INDUSTRIAL ENGINEERING

ELECTRICAL, MECHANICAL AND PLANT SERVICE IN INDUSTRY

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Think straight about HOUSEKEEPING in industry

. . . She is a good housekeeper!—or—She is a poor housekeeper! How anxiously the bride awaits the verdict of her friends and acquaintances. And, as time goes on, she makes heroic efforts to retain the good verdict or change the poor.

. . . Industry can profit by going back occasionally to the simple organization of the household for comparison.

. . . Good housekeeping in the home means, for one thing, keeping the place clean, and it is cleanliness or lack of it that probably most strongly influences the verdict of good or poor.

. . . But there are other important divisions of housekeeping in the home—systematic repair and replacement of the home equipment, orderly maintenance of stores and supplies, regular purchase of services. In the simple home the wife performs all of the duties—in the more elaborate home she directs them.

. . . Housekeeping in industry is maintenance in its broader sense. True, it includes such lowly duties as keeping the plant and equipment clean. It also includes repair and replacement, maintenance of stores and supplies, specification of equipment, inspection for service. In the smaller plants the individual charged with the duties of housekeeping may do most of the work himself. In the largest plants he is the directing head of a considerable group.

. . . Housekeeping is a service to production in both industry and the home. Installation, lubrication, repair, replacement of production and materials handling equipment; maintenance of structures, lighting, signal and protection systems; selection and maintenance of transmission equipment; all these are housekeeping functions in industry that make it possible for production to be carried on. Feeding, cleaning, mending, furnishing in the home provide the background that makes it possible for the producer (of income) to go on producing.

. . . Organization is essential to housekeeping in the home. Records of purchases, of consumption, of stores must be kept; budgets based on past performances must be followed; duties allocated; inspection carried on.

. . . Organization is also essential to housekeeping in industry. Procedure fundamentally the same as that in the home must be followed. In small plants it may be simple; in large plants it becomes complicated.

. . . A trite illustration, this comparison of service-to-production in the home with service-to-production in the plant; nevertheless, a justified illustration. It is necessary occasionally for engineers as well as other individuals to hark back to elementary examples of fundamental principles in order to gain true perspective. This procedure is especially necessary, perhaps, when it comes to housekeeping, or maintenance, or service-to-production, or plant engineering—call it what you will.

In this department aluminum tubing is produced ranging from ⅛ to 10 in. in diameter.

How we are organized fo

By W. G. ROSS

Chief Engineer
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KEEPING the equipment in proper condition and the buildings clean and sanitary is not an easy job in the average plant of any size. When, however, the equipment is largely of special design and must be kept going 24 hours a day in hard service the problems that are normally met are considerably increased in both complexity and number. These are roughly the conditions that we have to face.

In our effort to solve these problems in the most efficient way we have evolved an organization and methods that differ considerably in some ways from those found in other plants. Nevertheless, our method of handling maintenance work has the advantage of possessing a large degree of flexibility and, what is of considerable importance, makes it possible for us to apply a large amount of highly specialized information to some of our maintenance problems.

Considering for a moment the extent and physical layout of our properties, the New Kensington works may be considered as consisting of three more or less separate plants. These are the Logans Ferry plant, the Arnold plant and the New Kensington plant proper. In these three plants a wide variety of aluminum products is produced, including aluminum bronze powder for painting, high-tensile-strength aluminum alloys, tubes and structural shapes, cooking utensils of all kinds, sheet aluminum for various purposes, foil and so on. Each plant is devoted to a separate type of product.

In these plants there are 24 separate departments which are housed in a total of 97 buildings. The plant grounds cover 73½ acres, of which 19.9 acres are under roof, giving a total of 27 acres of floor space.

Power for operating the machines in the departments is furnished by 1,278 motors ranging from ⅛ to 1,000-hp. rating, with an aggregate rating of 17,463 hp. Within four months we expect to add about 5,500 additional horsepower in motors to increase our productive capacity. About 35 per cent of our power load is in 250-volt, d. c. motors. Some of this equipment is quite old, having been installed in the early days of the plant. The remainder consists largely of variable-speed d. c. motors which are used on all drives where speed variations are necessary.

The majority of the smaller, general-purpose motors used on constant-speed drives are of the 440-volt, squirrel-cage type. On pumps, compressors, and motor-generator sets supplying power for the d. c. motors we use 80 per cent power factor synchronous motors. These synchronous motors enable us to operate at a plant power factor of about 97 per cent.

We generate about three-fourths of our electrical energy by four turbo-generator sets, of which three are 2,200-volt, three-phase, a. c. machines; the third is a 250-volt, d. c. generator. The remainder of our power is purchased at 25,000 volts, three-phase, and stepped down to 2,300 volts through two transformer banks. From the power house and substations the a. c. power is distributed through overhead lines to the different departments and stepped down through nine large transformer banks, located at the principal load centers, to 440 volts. Small 110-volt, single-phase transformers supply the lighting service for the different buildings.

Illumination is furnished by approximately 10,000 general lighting units representing a total load of about 782 kw. The nature of most of our work is such that good illumination is absolutely essential; hence we use plenty of it. Furthermore, the light furnished by mercury vapor lamps is particularly well adapted to inspection and certain other kinds of work. Therefore,

A battery of rolls used in the rolling of aluminum sheet.

d *for* Maintenance *and* Plant Housekeeping

we use a total of 711,500-watt, Cooper-Hewitt lamps; these represent about half of our present lighting load.

Responsibility for all maintenance and plant engineering work in general is vested in the chief engineer. The work of his department is carried on by eight major divisions designated as construction, maintenance, lubrication, power, etc. The organization scheme is shown by the chart on page 180, which covers the activities of present interest.

We are firm believers in the budget system and apply it to all of our work. The head of each division makes a monthly budget covering the work that he estimates will be necessary during that month. These estimates are discussed with the superintendents of the departments in question in order to minimize mistakes and maintain harmony in the plant organization. Naturally, every department wants to keep all costs down as much as possible; hence proposed expenditures are carefully considered, but mere desire to keep expenses down is not allowed to interfere with the execution of needed work. When completed the budgets are sent to the chief engineer for approval.

Estimates are made of the cost of all proposed work and submitted to the chief engineer for approval in case the cost does not exceed $500. When the cost is above $500, it is necessary to issue a Request for Authorization. On this form the nature of the work, reason for doing it, estimated cost, benefits expected, and other pertinent data must be put down. Upon approval by the chief engineer the request is sent to the plant superintendent and if he in turn approves it, it is sent to the main office of the company where it is acted on by a committee and either approved or rejected.

We feel that our policy of making monthly budgets for maintenance work has several important advantages. In the first place, it enables us to keep a close watch on the cost of this work. If the actual cost exceeds the estimated cost by any considerable amount a satisfactory explanation must be forthcoming from the offending department.

Again, it makes us keep a close watch on equipment in order to detect abnormal conditions or impending trouble as soon as possible. It may not be feasible or necessary to make repairs immediately, but the fact that we know certain work must be done enables us to plan ahead so that our activities can be carried on with the least expense and inconvenience.

Taking up our activities in the order in which they appear on the organization chart, all construction work and the care of buildings and grounds are handled by one division, which has charge of the carpenters, masons, painters, and so on. Frequent inspections are made of the physical condition of all buildings and structures and repairs or replacements are made when necessary.

Painting is handled in much the same manner. That is, conditions in different buildings and departments vary considerably so that it is hardly feasible to have a set program for painting. Instead, whenever inspection shows that certain surfaces need repainting the work is done. The same thing applies to floors, roofs and other surfaces. Repairs are made whenever the necessity for them becomes apparent.

Building alterations and minor construction are handled by the plant force, an appropriation being made, as explained above, when the cost of the work will exceed $500. Major construction, such as the erection of a building, is handled on contract with outside concerns, but the complete plans are drawn and the work supervised by the plant construction department.

Janitor and watchman service are supervised by the personnel department, but will be mentioned here as they are important activities. One or two men, as may be required, are stationed in each department and spend their time in collecting and removing all refuse and keeping the place as clean as possible.

Maintenance of mechanical power drives and allied equipment is handled by one or two millwrights and assistants stationed permanently in each department. We use direct drive whenever possible, but there are many places where it is necessary to use belts, chains, or speed reducers. The millwrights make daily inspections of this equipment, take care of its lubrication and make whatever repairs or adjustments are needed. In addition, they handle the installation of new equipment and changes on the old. All of this work is charged against a standing order applying to the job.

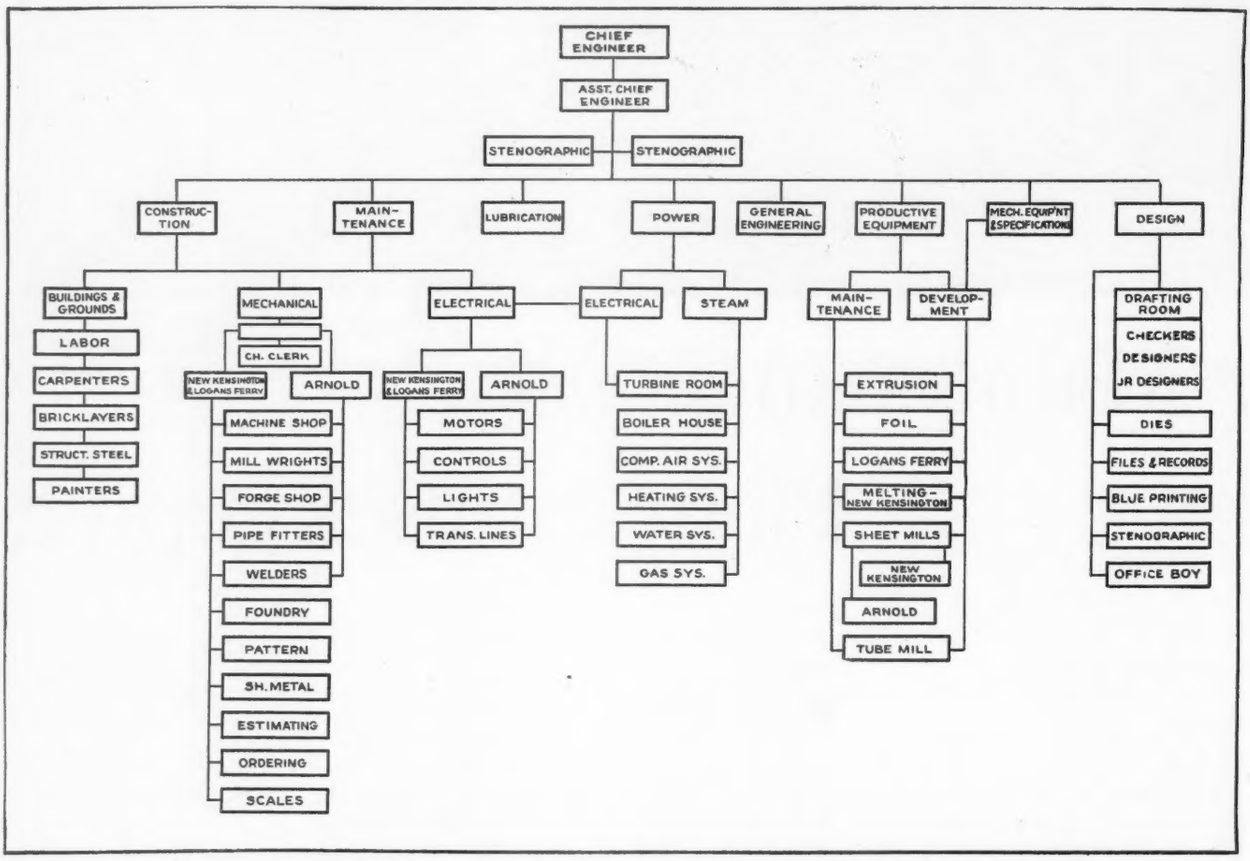
When supplies or parts are needed a Storeroom Requisition, shown on page 181, is filled out in triplicate and signed by the engineer in charge. This order shows the account number, department to which the material should be charged, and other data. One copy of this requisition is sent to the storeroom, one to the chief engineer's office and one to the cost department. If it is necessary to have work, such as making new bearings and the like, done by the machine shop or other department, the department engineer issues a Request for Shop Order, a copy of which is filed in the chief engineer's office, on the cost department, in case the estimated cost is less than $500. If it is more than $500 an appropriation must be secured as outlined above.

Upon the approval of this request a Shop Order is issued containing complete instructions covering the nature of the work and how it shall be charged. A copy of this Shop Order is sent to all departments concerned. The order is issued in quadruplicate: foreman's copy, labor copy, material copy and recapitulation sheet. The various items are entered on the corresponding copy and upon completion of the work all copies are sent to the cost department.

These order forms and the general routine just described are used for all of our maintenance and development work.

Electrical inspection and maintenance is handled by a force of 36 men under the direction of the chief electrician, with an assistant chief electrician at the Arnold and New Kensington plants. Maintenance of electrical equipment at the Logans Ferry plant is taken care of by the New Kensington force. Four men serve as motor and control inspectors. They go over all important motors and controls once a day, oil the motors, make any adjustments or minor repairs that may be necessary and in general are responsible for the continuous operation of the equipment. All cases of trouble, including the cause, time lost, repairs made and so on are reported at once by memorandum to the department engineer.

A Shop Order is issued by the

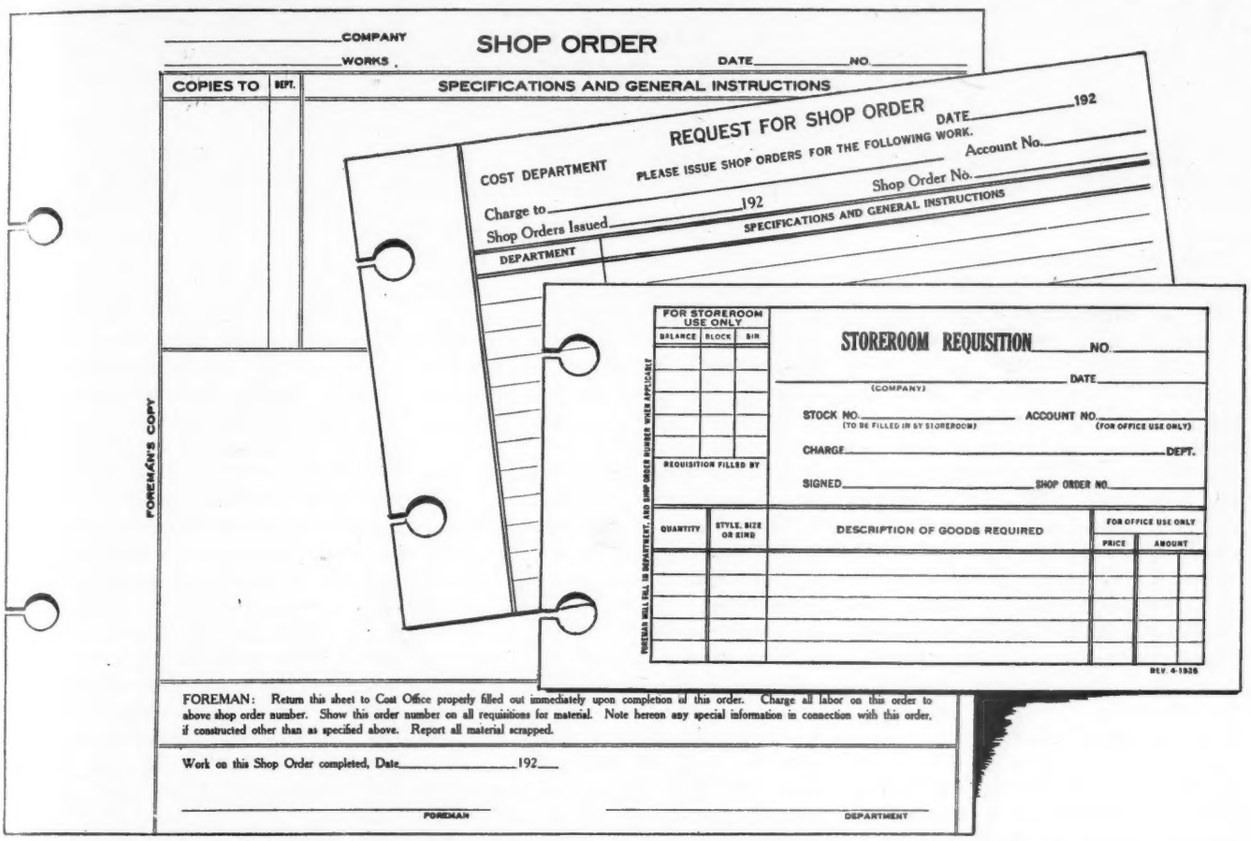


ORGANIZATION CHART of engineering division for handling plant maintenance and development work.

chief electrician for all work that cannot be handled by the inspectors on their daily rounds. If the work is likely to exceed $25 or $30 an estimate of the cost is made before the Shop Order is issued. All such orders are approved by the chief engineer.

Two men devote their entire time to inspection and maintenance work on the transmission and distribution lines, making daily inspections and the plants for metering the power required by the different departments. In addition, ammeters are used with many of the larger motors, particularly those driving rolls, in order to help the operator avoid excessive overloads. An expert meter man devotes all his time to the inspection, repair and checking of these instruments. The watt-hour meters are checked at least once a year. When convenient the meters are checked out or develop defects that make rewinding necessary.

We have long recognized the prime importance of proper lubrication of our equipment, some of which presents very interesting problems. The necessity for solving these problems in the best way led us to appoint a lubrication engineer whose duty is it to study all problems dealing with the lubrication of our equipment, specify the proper materials



SUPPLIES and materials are drawn from stock on the Storeroom Requisition which is signed by the engineer in charge. Work to be done by any of the plant departments is initiated on the Request for Shop Order. The Shop Order gives the different departments authority and instructions for doing whatever work may be required of them. Each department concerned receives a copy.

doing whatever is necessary to keep the lines in the proper operating condition.

It was mentioned before that good illumination is an important factor in the operation of our plants. To make sure that our lighting systems operate at the maximum efficiency at all times, three men spend all of their time in going over the systems, replacing burned-out or blackened bulbs, cleaning lamps and reflectors and doing whatever work is needed. Lighting units in the offices are inspected every morning. On the average all units throughout the plant are washed at least four times a year, and oftener if necessary.

A total of 92 watt-hour meters are used in the power house and out in out in the plant against a rotating standard; otherwise they are taken to the repair shop for testing and recalibration.

The electrical department also handles all maintenance and repair work on two storage battery trucks and one gasoline truck that form part of the plant materials handling system.

We operate our own repair shop for electrical equipment, but as a rule do not rewind motors over 5 hp. in rating. Owing to our proximity to the large commercial repair shops and service stations in Pittsburgh we can easily obtain such prompt and reliable service that it would hardly pay us to provide all of the necessary facilities for rewinding the small number of large motors that burn for each application, and in general oversee this important phase of plant engineering work.

The power house and equipment therein are in charge of a power engineer who is responsible for operation, maintenance and all activities concerned with that equipment. This division also handles all work concerned with the maintenance of the heating, gas, compressed air, and water systems.

In connection with these services a good part of our work is educational in the way of teaching foremen and employees to avoid waste. It is easy to waste air, gas, water and so on, for example through failure to turn these off when machines

(Please Turn to Page 209)

Fighting *Rust and Corrosion* with

Better Painting Methods

By ROY C. SHEELER

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MANY ESTIMATES have been made of the loss sustained each year through preventable corrosion. One guess is as good as another, but it reaches a truly staggering sum. And the worst part of this is the fact that most of it could have been prevented if corrective measures had been taken in time.

But first of all, what is rust or corrosion? Stripping it down to the bare fact, corrosion is the gradual return of metal surfaces to their original state.

Various theories have been advanced covering the cause of corrosion. One authority says, "Iron will not corrode in air unless moisture is present and it will not corrode in water unless air is present. The agents present in the air which accelerate corrosion, especially in air near cities where much fuel is consumed, are numerous; but sulphur dioxide and soot are probably the most destructive, because together in the presence of moisture, they produce sulphuric acid."

Rust is simply the gradual wearing away of the surface of iron or steel due to exposure to the oxygen and moisture in the atmosphere. This is the main cause. There are others equally important. The presence of gases and fumes from manufacturing processes have an important bearing upon the rapidity of rust formation. Stray electric currents frequently stimulate rust, especially if they have the opportunity to unite with a rust-stimulating pigment on a metal surface, such as artificial graphite.

In the manufacture of steel, certain impurities are incorporated into the mixture. These impurities show up in spots, which generally are the first to be attacked. Rust prevention is a real problem in many industrial plants, particularly those where manufacturing processes also contribute to the rapid acceleration of rusting.

In most plants, however, there are many opportunities for the application of preventive measures, and these are now to be discussed.

Prevention of Corrosion

In order to accomplish successful results in the fight against rust, there are certain fundamental principles which must be observed. Of first importance is the proper preparation of the surface, so that the paint selected will have an opportunity to unite with the metal and create an impervious film. Too much attention cannot be paid to this detail.

No matter how well suited the protective coating may be for the work to be done, it is utterly useless to apply it over a thick coat of rust, or on a wet surface, and expect satisfactory results to follow. Painting over rust is like applying paint to the bark of a tree. There is absolutely no chance for proper adhesion to be obtained. In the case of the tree, when the bark comes off, the paint comes off also.

With the coat of rust next to the metal, it allows the paint film to lie upon the surface of the rust only, having absolutely no action upon the body of the metal itself. Furthermore, the canker of rust will proceed beneath the paint coat and in time completely destroy the life of the structure, and for the most part unseen.

A certain plant manufacturing chemicals had a great deal of trouble in the attempt to prevent extremely rapid rusting of structural steel supports and beams. Here, the production processes were severe, but with proper care, it was possible to remove the heavy film of rust before painting.

In order to prove to the engineer that rust removal was absolutely necessary, two coats of paint were given a section of the plant, half of which had practically no preparation, while on the other portion the rust was wire-brushed and scraped down to the bare metal. Inside of two months, the surfaces repainted without cleaning were in a worse condition than at the time the painting was done. Those surfaces that had been carefully cleaned were in relatively good shape, with slight rust spots here and there. The extra cost of labor for cleaning amounted to approximately 25 per cent over the total cost of labor and paint for the portion not properly cleaned.

It is equally foolish to paint over a metal surface on which there is a thin film of mill scale. This lesson has been learned especially well in the oil fields, and by those industries having steel tanks to protect. In one instance, a company having a number of such surfaces to protect was anxious to have the painting done before winter. Some of the tanks had not been erected long enough for the scale to wear off properly under weather exposure. They tried to remove as much as possible by scraping, but there was still a considerable amount left that refused to let go. So they took a chance and painted over it.

For a number of months these tanks looked as well as the others. Then in the late spring following, an examination showed that the film was beginning to peel off in small sections. A closer examination of the peeled film showed that the mill scale was loosening from the surface, bringing the paint coat with it. This resulted in a much greater cost to take off the partially peeled paint, thoroughly clean down the surface, and place in condition for repainting.

If this scale is on a surface exposed to the atmosphere, it is best to permit the surface to "weather" for a period of six months or more, until the scale had rusted off. The surface should then be gone over with scrapers and wire brushes, so that every evidence of scale and consequent powdered rust is removed. The surface is then in proper condition for painting.

IT IS ON SURFACES such as these that the problems of mill scale and rust prevention are of vital interest to plant engineers.

Wherever rust is present, inside or outside, it must be entirely removed by scraping or wire brushing before the painting is done. Then see that the surface is dry.

Many plants are faced with the problem of painting under moist conditions, where it is almost impossible to remove the wetness of the surface. A textile plant faced with this problem worked it out by shutting down on Saturday morning and turning on forced heat and employing auxiliary fans to set up a current of air. This treatment was carried on all day and through the night. The first coat was then applied on Sunday morning. Concrete and metal surfaces were included, and they had no difficulty through this plan in securing a dry metal surface and a fairly dry concrete surface. The painting was done on Sunday, and by keeping up the "heat treatment" until Monday morning, the paint was dry enough so that production could be carried on as usual.

The Paint Itself

Second in importance to the proper preparation of the surface is the selection of the paint or protective coat to be applied. A paint to be efficient in rust prevention must be composed of suitable pigments combined with the proper type of vehicle (the liquid portion of the paint), the resultant product to possess the following characteristics: Chemically permanent; Chemically inert toward iron; Resistant to physical contact; Resistant to contact with air and mosture; Sufficiently elastic to allow for contraction and expansion without cracking; Rust-inhibitive (resistant to corrosion).

Chemical Permanence—There must be a mutual attraction between the pigment and the oil or vehicle, and the particles of pigment must be very finely ground, in order that the finished film will present a smooth, unbroken surface. This is exceedingly important. For instance, in red lead of the best quality, the particles of pigment have a strong attraction for the oil and readily combine with it, thus making a continuous film. If this attraction does not exist, the paint may brush out satisfactorily, but be very porous when dry, and not produce a good surface, thereby giving poor protection to the metal beneath.

The speed of drying is an important factor. Paint for the most part dries by the absorption of oxygen from the air. It is a slow chemical process and should not be accelerated too much by artificial means.

The indiscriminate addition of artificial dryers can not be too severely condemned. Although these agencies will assist in the drying, they at the same time burn out the life of the paint coat with consequent early breaking down. Give the paint a chance to prove its efficiency by not hurrying the drying process too much.

For instance, not long ago a plant engineer desired to paint his electric switch boxes a bright green, and for this purpose chose a ready-mixed paint that was designed for outside woodwork. It made an attractive appearance, but this plant engineer complained about the slow-drying because after four days the surface was still "tacky." This condition was but natural, since he had used a paint that had been manufactured for an entirely different purpose. What he should have used was a hard-drying enamel of the proper shade, which normally would dry over-night leaving a hard, durable surface. Even though the paint used dried properly, it was unsatisfactory because, it was too soft to resist the physical contact as well as manufacturing conditions in the plant.

Chemical Inertness Towards Iron—Certain pigments stimulate rust in themselves. The chief offenders are those of the graphite character. These pigments may be used with successful results as finishing coats, but they should never be applied next to the metal.

Then there are other pigments which are chemically inert, that is, they neither stimulate nor prevent rust in themselves. When these are combined with a suitable vehicle, they constitute satisfactory metal finishes, especially if they are applied over the first coat of a known inhibitive or rust-preventative. There are a number of pigments that rate highly as rust inhibitors, namely; sublimed blue lead, red lead, carbon black, zinc chromate and basic lead chromate, or American vermilion. The last named material is a main constituent in some of the most successful first-coaters for metal surfaces. It possesses in itself the peculiar ability to resist rust, both of the electrolytic nature as well as that produced by moisture contact. For the most part, therefore, the plant engineer should insist upon the paint for priming purposes be composed of a high percentage of this important pigment.

As an example, one plant engineer had secured unusually satisfactory results from the use of a certain paint for the finishing coats on tanks and other exterior metal surfaces that he decided to apply the same treatment on certain new tanks, using the same material for both first and finishing coats. In a short time he was amazed to find the surface full of heavy rust pores. Electrolysis developed and was stimulated by the presence of the rust-exciting pigment in the mixture. Had a rust-inhibitive coat been used as a primer, and this product used for finishing coats, a completely satisfactory result would have followed.

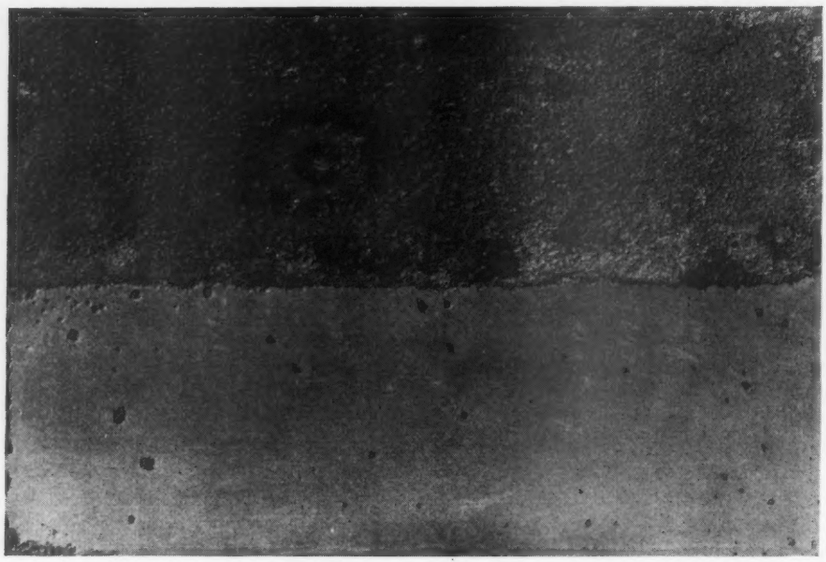
Resistance to Physical Damage and Proper Elasticity—It is obvious that a paint to successfully protect a metal surface should possess sufficient elasticity to expand and contract with the metal, and not scale off in the process. The nature of the vehicle determines the ability of the paint to do this. Paint may crack on its outer surface only and not go through to the metal. This condition is caused generally by not permitting sufficient time for the first coat to become thoroughly dry before applying the finishing coat. The first coat must dry with a certain degree of hardness and yet remain tough and elastic. This characteristic has an important bearing upon the wearing quality of the subsequent coats.

One can readily see, therefore, why a linseed-oil film of house paint is not at all suitable to paint machinery and equipment. One plant engineer got out of trouble of this sort by sandpapering the surface when dry, and applying a coat of a varnish-vehicle floor paint. This dried over night with a hard, resistant surface, and it made a very good finish.

In these days of modern methods, there is small likelihood of trouble with application. This statement is especially true with brush work, but not altogether the case when the spray gun is used. Most plant engineers insist on the use of more or less contrasting colors for the various coats, so that "holidays" will be detected and each color act as a check to the next coat.

Doing outside work in cold weather is a condition under which one plant engineer had trouble. The temperature was down to about 36 deg. F., and as a consequence, thorough brushing was difficult, if not impossible. The man applied the paint heavily, piling it up so that it crept and wrinkled and did not dry properly underneath. The addition of a slight amount of turpentine helped materially to secure a thinner coat, thereby allowing proper brushing. The danger here is the addition of too much thinner, resulting in deficient hiding and a coat much too thin for weather resistance.

The plant engineer of today, in a plant of any size, is charged with so many responsibilities that he has found it advisable to have at least one man in his organization in direct charge of the painting program. To this individual there is available a vast amount of general information that will help him in the fight against rust and corrosion.



AFTER A FIVE-YEAR EXPOSURE. A steel panel, the lower half of which had been treated with a coat of a high-grade rust-inhibitive primer followed by a coat of a good quality linseed oil paint. The upper half shows what takes place without the rust-inhibitive first coat.

McGraw-Hill to Publish "Aviation"

ANNOUNCEMENT was made during March that the McGraw-Hill Publishing Company, Inc., New York, has purchased and will publish *Aviation,* the oldest aeronautical magazine in the United States, established in 1917 by Major Lester D. Gardner.

This change of ownership presages an improved publication, and a more complete service to the aeronautic industry, due to the extensive publishing resources of the new owners. These resources are available largely on account of the wide industrial contacts of the company through its total of twenty-five publications.

Because of the rapid growth of the aeronautic industry and its influence upon all other industries, the acquisition of *Aviation* by McGraw-Hill is of interest to the readers of *Industrial Engineering.* In service-to-production the same problems that exist in the plants of other industries are present in the aeronautic plants. From the newer industry may come plans and methods that will be of value to all; if so, the precedent set in the automotive industry will be followed.

On service-to-production the development of the airplane has already had an effect that will grow. Rapid transportation of orders and parts by air has many times prevented serious delays in production. As transportation by way of the air multiplies, another valuable support is added to the tools of the men who must see that equipment and plant always are ready for service.

James H. McGraw, chairman of the board of the McGraw-Hill Publishing Company, in referring to the acquisition of *Aviation,* said, "We assume the publishing direction of *Aviation* with the conviction that the resources of the McGraw-Hill organization will bring new strength to this paper and practical benefits to the industry beyond the reach of a single publication. We enter this field only because it is clear that there is an opportunity to render a service that will advance the art of flying and its economic development."

Aviation was purchased from the Aviation Publishing Company, New York. Earl D. Osborn, who has been publisher of the periodical for several years, has joined the McGraw-Hill organization and is continuing his activities in the field of the magazine. Publication is from New York.

POWER TRANSMISSION

By Short-Center Belt Drives

By WILLIAM STANIAR

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Power Transmission Association
Power Transmission Engineer
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THE disadvantages of the open-belted, short-center driving installation were discussed briefly in the preceding articles in the January and February issues. The obvious faults of such drives have led to the development of various types of apparatus to overcome them.

The automatic-idler system is in reality a development of the ordinary idler or tightener pulley. Before its advent, the placing of an idler-tightener pulley was generally a matter of guesswork, but now the several automatic devices on the market place it and control it in a scientific manner. The chief function of this device is to increase the arc of contact on the driving pulley, thereby overcoming the main difficulty of the short-center drive. Fig. 1 illustrates the practical effect of arc increase on power ratings, based on 180 deg.

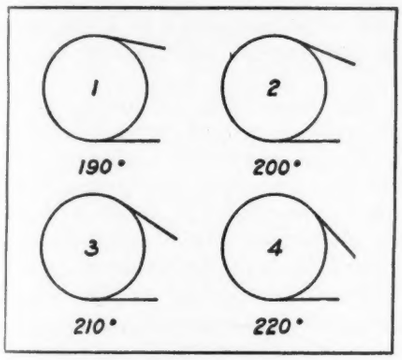

FIG. 1—POWER-TRANSMITTING capacity increases as the arc of contact on the small pulley grows larger. Taking a 180-deg. arc as standard, at 190 deg., diagram *1*, the power rating is increased 4 per cent; the increase in rating is 8 per cent at 200 deg., diagram *2*; 11 per cent at 210 deg., diagram *3*, and 15 per cent at 220 deg., diagram *4*.

* * * *

A diagrammatic view of the automatic-idler device is shown in Fig. 2. Here a 125-hp. motor is tandem-connected to a beater on 9-ft. 6-in. centers. It will be noted that the fulcrum or idler pulley is applied to the belt in such a manner as to equal the belt tension and increase the arc of contact automatically and in accordance with the load transmitted. The elongation, or stretch of the belt due to its elasticity, is in synchronism with the variations in the power transmitted; therefore, when the power is maximum, the arc and the grip of the belt on the pulley are also maximum. This system is not detrimental to belting life if the proper endless type is employed, but a metallic fastener should not be used on the belt.

This method is also applicable to vertical driving, as shown by Fig. 3, which illustrates a 75-hp., 5-to-1 ratio installation. Fig. 4 shows its application to a horizontal drive, with high ratio and short center distance, between a 300-hp. gas engine and a generator. These illustrations show bottom-pull installations.

However, the same system is also applicable to top-pull installations. Fig. 5 illustrates the method employed for high-powered drives, and Fig. 6 for drives under 20-hp. rating.

The multiple V-shaped rubber-and-fabric drive is an adaptation of the English multiple, endless-rope drive with the exception that it employs V-shaped ropes of rubber and fabric composition operating on multiple V-grooved wheels. It has proven to be an excellent transmitter of power at close range. The greater the load tension, the greater the adhesion to the grooves of the wedge-shaped belting sheaves; therefore, slip is almost entirely eliminated, when correct proportions are established for the power requirements. This method of driving is not only successful on short-center work, but has shown efficient operation on center distances up to 12 ft. and in power capacities from ½ to 2,000 hp.

Short-center distances are preferred for this drive and can be somewhat less than the diameter of the larger wheel. Diameters and widths of sheaves average a trifle greater than for spur gears or chains of similar rating, but less than regular belting drives with idlers.

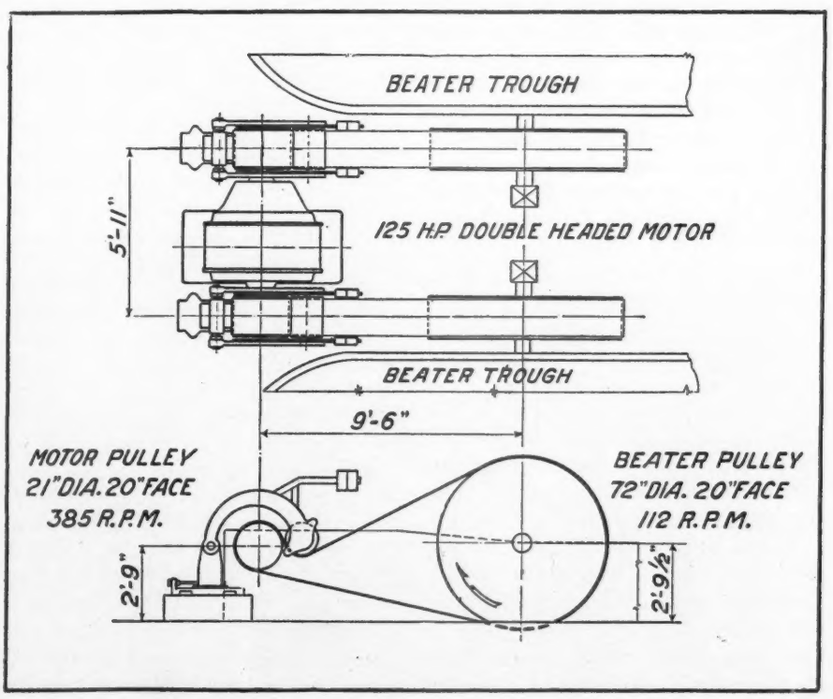

FIG. 2—LAYOUT of automatic-idler drive for a beater. The motor is 125-hp. rating and drives the beater on 9 ft. 6 in. centers.

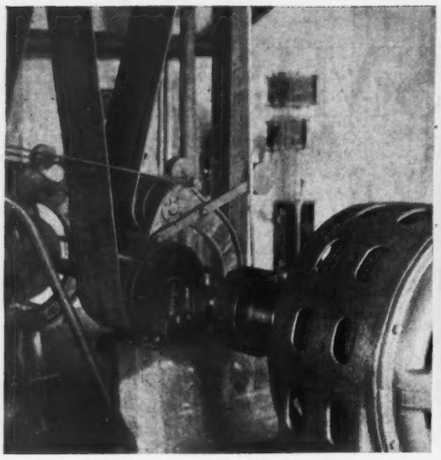

FIG. 3—HERE is a vertical application of an automatic idler. This drive is rated at 75 hp.

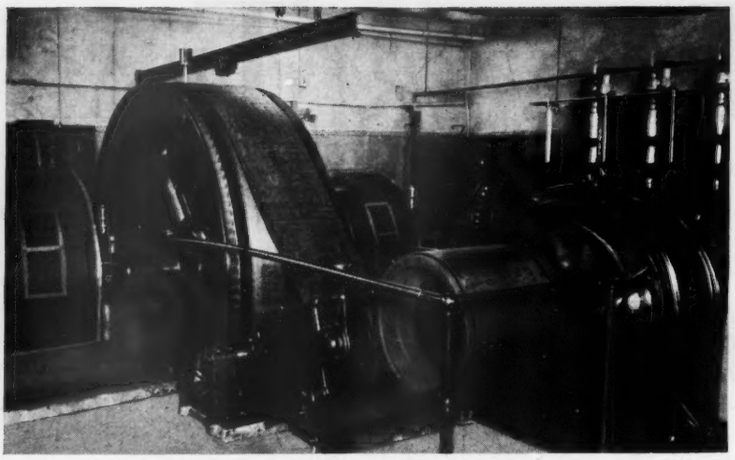

FIG. 4—A HIGH RATIO and short center distance characterized this automatic-idler installation. The generator is driven by a 300-hp. gas engine.

There is a minimum of slip; therefore, speed ratios are maintained under heavy loads. Another advantage is that if one rope breaks it is not necessary to shut the machine down immediately as the remaining ropes will carry the load for a time.

The ropes can be set at any angle to the horizontal, and can be used for vertical driving without difficulty.

Rope speeds up to 6,500 f.p.m. are permissible. This drive can be used for high speeds, for shock or pulsating loads, where silence of operation or extreme cleanliness are necessary, on short and medium center distances, and for wet and sloppy conditions.

It should not be used where the atmospheric temperature is over 120 deg. F., where adjustment of at least 5 per cent of the center distance to compensate for rope stretch cannot be obtained, where the arc of contact of the ropes on the small sheaves is less than 120 deg., on quarter-twist drives, for ratios over 7 to 1, or where excess mineral oil can come in contact with the ropes.

Fig. 7 shows this type of drive on a 65-hp. motor to a headshaft on 49-in. centers, with a speed reduction of 710 to 156 r.p.m.

The power capacities of this method of driving are given in the table. The ratings given are for one strand of rope; therefore, the number of ropes employed depends upon the power requirements.

There are many occasions for using ratios ranging from 15 to 1 to 30 to 1. Counter- and jackshafting may be out of the question. Worm-gear or spur-gear reduction units may be too rigid. The short-center driving methods just discussed cannot cope with these high ratios. To meet such requirements, a device of foreign origin has recently been introduced into this country. It utilizes a principle of mechanics that has not been considered for direct-power transmission, and consists of a gear, pinion, pulley, spindle, and fulcrum arm.

The pulley and pinion are keyed to the spindle which is supported by

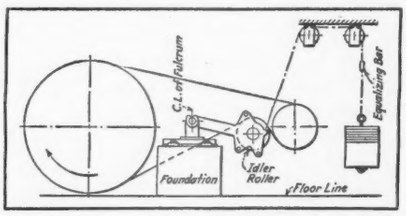

FIG. 5—A METHOD of keeping the idler under tension on a high-power, top-pull installation.

* * * *

the fulcrum arm centered on the shaft to be driven. The gear is keyed on the shaft to be driven and meshes with the pinion on the spindle. Thus, in the rotation of the spindle by the aid of a belt drive to the spindle pulley, the pinion tends to make an epicyclic movement around the gear wheel with which it meshes, but such movement is restrained when the belt has been put under tension, and the continued rotation of the pinion will rotate the gear wheel and operate the apparatus or lineshaft.

The degree of tension on the driving belt depends upon the inertia to be overcome in starting the load and pulling it, so that the belt always retains the correct tension for the power requirements. This method of driving is unique, but the chief feature is the automatic application of load tension on the ordinary open-driving belt without the aid of spring- or weight-controlled idler pulleys. Furthermore, the centers of the belt drive do not appear to affect the efficiency of the mechanism.

Fig. 8 illustrates its application to a low-powered shaft. The gears of the mechanism are encased and the motor is belted on a close center. The ratio in this case is controlled entirely by the gear ratio of the device, as the belt drive is approximately 1 to 1. A gear ratio of 8 to 1 has been built; therefore, if the belt connection to the device is 4 to 1, the final speed-reduction ratio would be 32 to 1.

The importance of joining belts properly when short-center drives are used was mentioned earlier in this article. Improper or careless joining for any drive is a steady drain on production, one of the principal causes of high maintenance and a direct cause of short belting life.

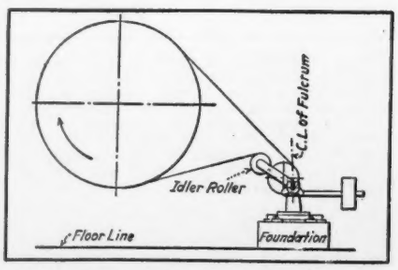

FIG. 6—THIS ARRANGEMENT for keeping tension on the idler is employed on top-pull installations of 20-hp. or smaller rating.

* * * *

A power belt joined to form an endless band is by far the most efficient from the power and safety standpoints, because the joint is integral with the belt, should possess the same flexibility, and grip the pulleys with the same frictional contact. It is the most economical joint and should be employed wherever pos-

sible. However, all types of belting have initial stretch and, unless there are take-up facilities on the drive, the endless method may cause serious shutdowns; therefore the advantages of other methods of joining.

HORSEPOWER RATINGS OF V-SHAPED RUBBER ROPES

Velocity in Feet per Minute	Size of Ropes				
	½ × 5/16 in.	21/32 × 7/16 in.	⅞ × ⅝ in.	1¼ × ¾ in.	1½ × 1 in.
1,000	1.2	1.6	3.0	5.5	7.5
1,200	1.4	1.9	3.4	6.5	8.9
1,400	1.6	2.2	3.8	7.5	10.3
1,600	1.9	2.5	4.3	8.4	11.6
1,800	2.1	2.8	4.9	9.2	12.8
2,000	2.3	3.1	5.5	10.0	14.0
2,200	2.5	3.3	5.9	11.0	15.2
2,400	2.7	3.6	6.3	12.0	16.4
2,600	2.8	3.8	6.7	12.9	17.5
2,800	3.0	4.0	7.1	13.7	18.5
3,000	3.2	4.2	7.5	14.5	19.75
3,400	3.4	4.6	8.3	15.7	21.25
3,800	3.7	4.9	8.8	16.9	23.00
4,000	3.7	5.0	9.0	17.5	23.35
4,500	3.9	5.2	9.0	18.5	23.5
4,800	3.9	5.2	9.0	18.5	23.5
5,000	3.9	5.2	9.0	18.5	23.5

The ratings given are based on one strand of rope.

In general, the endless joint should be used:

1. On motor drives when center adjustment is possible.
2. On automatic-idler installations.
3. On high-speed spindles of machine tools.
4. On high-speed, accurate grinding operations.
5. On mule-pulley installations.
6. On large engine drives.

The endless joint is not suitable on drives where center adjustment is not possible, on vertical drives without idlers, or on quarter-twist drives.

Leather offers the greatest possibilities for the endless or cemented joint because the leather belt is made up of cemented joints; therefore, when cementing the ends of a leather belt together the same process is employed as is used in its manufacture. The ends of the belt are scarfed down to a thin edge 3, 4, or 6 in. back, depending upon the width; the cement or glue is applied and the joint placed under pressure for a short time.

It is always preferable to have the manufacturer make the endless joint, but it can be done at the point of application. In the case of extremely wide leather belting for high power engines, it is imperative to make the endless joint after the belt has been placed on the pulleys.

Rubber belts are now built endless by some manufacturers, without splices or joints. A rubber belt should be made endless by the manufacturer because vulcanization is necessary and this is not possible at the point of application. In making a rubber belt endless, other manufacturers cut the plies of duck back as shown in Fig. 9 and apply rubber friction compound. The joint is then vulcanized. In addition, some manufacturers reinforce the joint by stitching.

Balata belt can be made endless in a manner similar to that employed with rubber, with the exception that

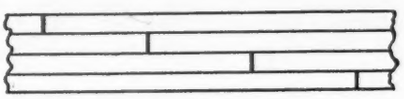

FIG. 9—RUBBER BELTS having from four to eight plies are usually made endless by cutting the plies back as shown, applying rubber friction compound, and then vulcanizing the joint.

* * * *

it is not vulcanized. The joint should be made by the manufacturer.

The laced joint is the oldest method of belt joining, as the first commercial joint was made by punching holes in each end of the belting material and lacing or tying the ends together by narrow strips of some sort of material. This method, in perfected form, is today known as the rawhide and wire-lace joint. If rawhide lacing is properly applied a good joint is the result and should be employed where hand shifting is necessary, because of its safety features.

The standard punching for leather belting to receive rawhide lace is shown in Fig. 10. The holes should be as small as possible and the width of the lace as narrow as power requirements permit.

The spacing of the holes is governed by the belt width; the generally accepted practice is five holes

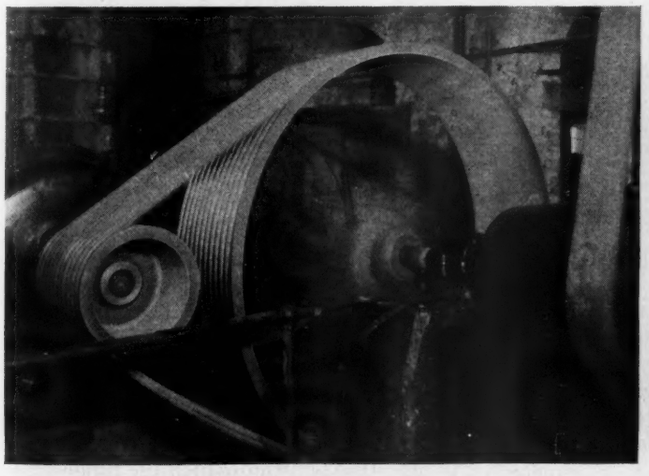

FIG. 7—THE V-ROPE DRIVE shown here is transmitting 65 hp. on 49-in. centers, with a speed reduction of 710 to 156 r.p.m.

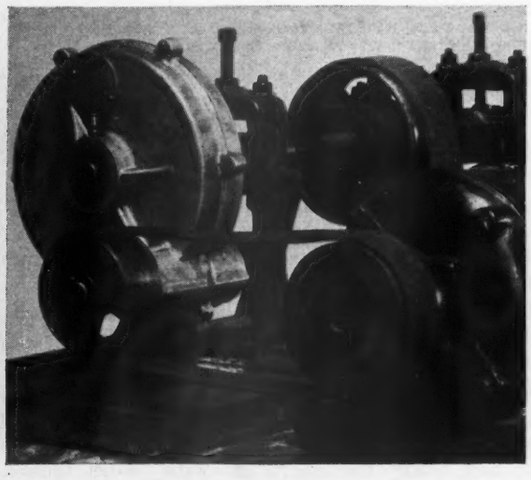

FIG. 8—IN THIS CASE the automatic belt tension apparatus is applied directly to the machine.

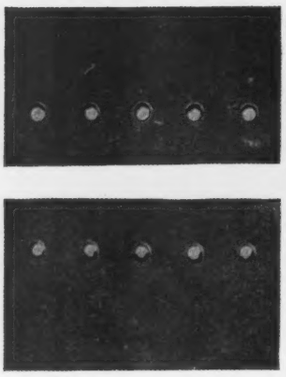

FIG. 10 (LEFT)—WHEN LACING rubber belts with rawhide, five holes are usually punched in a belt 4 in. wide; with wider belts the number of holes is increased correspondingly. One hole should always be placed in the center, to insure straight running.

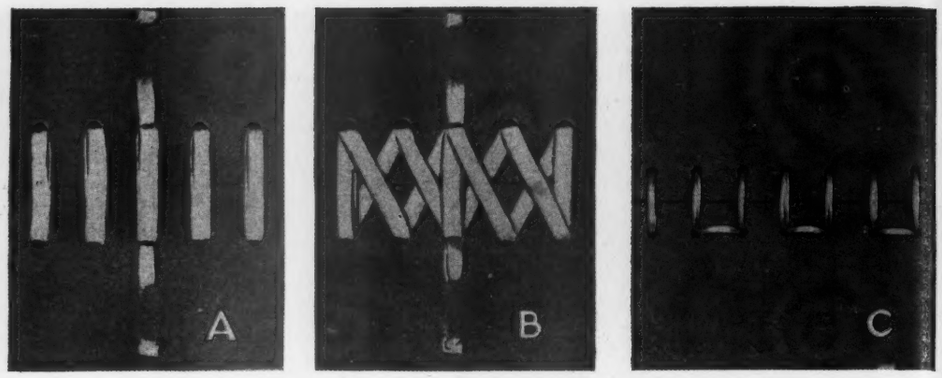

FIG. 11—MODERN PRACTICE is to apply rawhide and wire lacings as shown here. View *A* shows the pulley side and *B* the outside of the rawhide joint. *C* illustrates the usual method employed when hand lacing with wire.

in belting 4 in. wide, with a proportionate number of holes for wider or narrower belting. One hole should always be on the center line to insure a straight-running belt.

The modern method of rawhide and soft-wire lacing is shown in Fig.

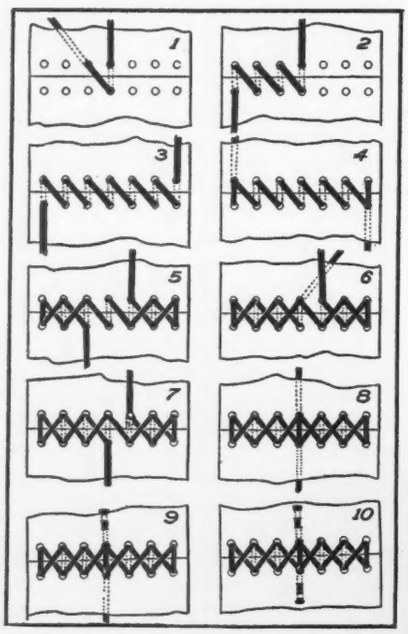

FIG. 12—STEP-BY-STEP procedure in making the rawhide-laced joints shown in Fig. 11.

* * * *

11. View *A* shows the pulley side and *B* the outside of the rawhide joint. View *C* illustrates the usual method employed when hand lacing with wire. Fig. 12 shows how to make the standard rawhide lacing shown in views *A* and *B* of Fig. 11.

There are a number of metallic belt fasteners on the market, each one possessing its own individual characteristics and uses.

Fig. 13 illustrates the modern wire-hook, hinge belting fastener assembled and ready for operation with the exception that the hinge pin is shown protruding. This type is extensively used because it is easy to apply and results in an accurate and flexible joint. The individual wire hooks are pressed into the ends of the belt to form a series of loops. To make the joint, these loops are meshed together and a rawhide pin inserted.

The hooks, which are made of a special steelwire, are furnished on cards and are applied by a small hand-operated machine, in which the carded hooks are inserted. The squared ends of the belt are inserted between the points of the series of hooks which are then pressed into the belt flush with the surface.

The hinge pin is made of either rawhide or fiber. This latter type must be machine-applied.

The hook-hinged fastener can be used:

1. On single, light-double, and regular double leather belting up to 8 in. wide.

2. On all types of fabric belting from two- to six-ply up to 8 in. wide.

3. On drives where it is necessary to unfasten the belt quickly.

4. On small, high-speed pulley work where it is impossible to use an endless belt.

5. Where a "dutchman" or "take-up" insert is required.

It is not suitable:

1. Where hand shifting is necessary.

2. On heavy-double leather belting of any width.

3. On leather belting over 8 in. wide.

4. On eight-, ten- and twelve-ply fabric belting.

5. On fabric belting over 8 in. wide.

6. Where acid fumes are present, unless the hooks are made of special, acid-resisting wire.

7. On automatic idler drives.

In any case, the successful operation of the hook fastener is based on the correct relation between size of hook, thickness of belt and pulley diameter, because a large hook cannot bend around a small pulley and, therefore, throws a strain on the belt.

Fig. 14 shows another form of hinge-pin joint assembled and ready for operation. This fastener is also extensively used because it can be applied quickly by hand and results in a strong, accurate, flexible joint. It is made of pressed steel and is so designed that when applied to the belt, flat loops are formed across the belt into which the hinge pins are inserted. Two steel pins, designed

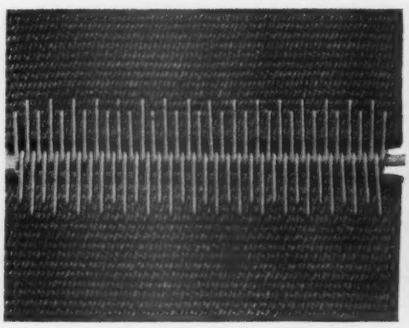

FIG. 13—THE WIRE-HOOK, hinged fastener makes a joint like this.

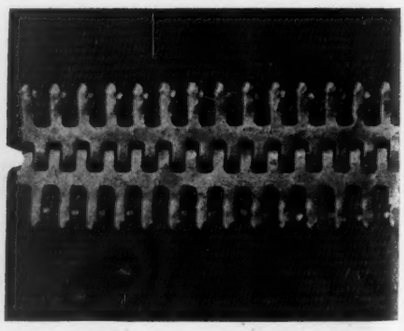

FIG. 14—THIS is the pressed-steel, hinge-pin fastener.

to give a rolling action on each other as the joint flexes on the pulleys, are used.

This type is furnished in strips with the jaws open. The end of the

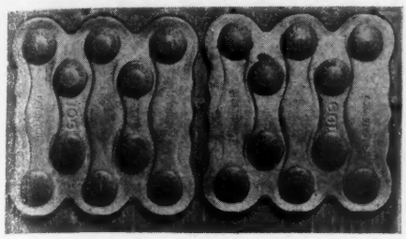

FIG. 15—THE MODERN TYPE of riveted plate fastener is used with double-prong steel rivets that spread and are clinched over when forced through the belt.

* * * *

belt is inserted in the jaws until it touches a stop on the fastener, which is then hammered so that the double-tooth jaws are forced into the belt, gripping it from both sides so as to secure a strong hold without weakening the material.

The pressed-steel, hinged hook can be used:

1. On all types of fabric belting from three- to eight-ply up to 10 in. wide.
2. On double- and single-leather belting up to 8 in. wide.
3. On hard-pull, slow-speed driving.
4. On drives where quick hand application is necessary.

It is not recommended:

1. Where hand shifting is necessary.
2. On any type of belting over 10 in. wide.

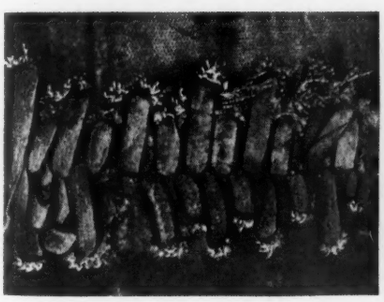

FIG. 18—CARELESS LACING of belts is likely to produce this result. Among the defects are: holes too large and too near the ends of the belts; holes not punched in line; sides of belt not in alignment.

* * * *

3. On ten- and twelve-ply fabric belting.
4. On automatic-idler installations.
5. On high-speed, small pulley work.
6. Where acid fumes are present.

Inasmuch as this type of fastener has considerable metal at the joint, care should be exercised in selecting the proper size for the pulley diameter and thickness of belt.

Fig. 15 illustrates a type of modern plate and rivet fastener. It is efficient and easy of application. This type combines great strength with light weight and is designed so as to distribute the power strain evenly across the entire width of the belt.

This type of plate is furnished in sizes proportionate to the width of the belt and is fastened to it by split-steel rivets which, when inserted in the plate and hammered through the belt, spread on the pulley side to a smooth running surface. No special tools are required to apply it. The plates are placed across the width of the belt, the butt ends of which are brought up evenly and tightly. The

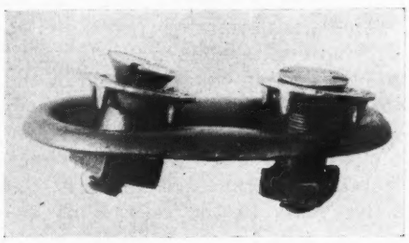

FIG. 16—WITH THIS type of fastener, known as the bolted plate, special bolts and washers are employed to fasten the plate to the belt.

* * * *

rivet employed is two-edged; therefore, when driven against any hard surface such as a pulley or shaft, spreading of the prongs results; the plates thus may be applied without removing the belt from the pulleys or shafting.

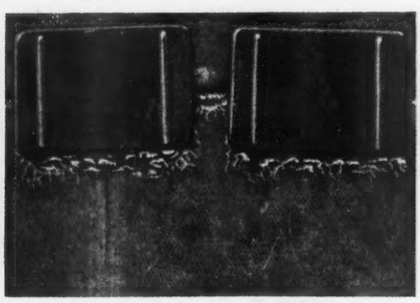

FIG. 19—CAREFUL application as well as a good fastener are needed to produce a good joint. Here the plates are too large and were improperly attached, causing them to dig into the belt as the latter bent around the pulley.

* * * *

The plate fastener may be used:

1. On single, light and regular double leather belting from 1 in. to any practical operating width.
2. On all types of fabric belting from three- to twelve-ply and 1 in. wide to any width required.
3. On open and crossed drives.
4. On hard-pull, slow-speed driving.
5. On shifting drives.

It is not suitable:

1. On automatic-idler or non-automatic-idler installations.
2. On high-speed, small pulley work.

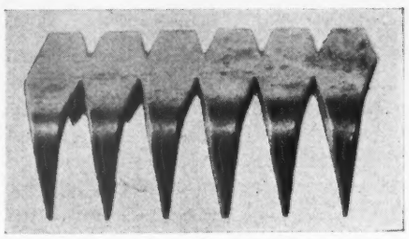

FIG. 17—A PRONG FASTENER like this is easily and quickly applied and produces a strong joint.

* * * *

3. Whenever any idler tightener is used.
4. On special tannage leather belting.
5. On hand-shifted belting.

The plate fastener, on account of its construction, forms a non-flexible belting joint; therefore, unless the size of plate conforms to the circumference of the pulley over which it operates there is always danger of premature breakage of the belt immediately back of the plate.

Fig. 16 illustrates another type of plate fastener which employs special bolts and washers for holding it to the belt. This type can be used to advantage on all types of belting and on most all widths and weights, but it is especially useful on the heavy-fabric mediums subject to heavy loads and intermittent strains. It is securely bolted to the belt and tearing out is almost impossible.

Fig. 17 shows a modern, hand-applied type of fastener which is strong and efficient when properly selected for pulley diameters. It produces a non-flexible joint and, therefore, should conform to the pulley circumference.

Carelessness in joining belts by any type of metallic fastener or any method is responsible for the majority of fastener troubles. Forty per cent of belting breakdowns are caused by careless preparation of the belt ends and careless application of the fastening method or device.

See that the ends of power belting are cut square before joining, that the proper method or device is employed for the conditions, and application made in a workmanlike manner. Figs. 17 and 18 show the effects on power belting of wrongly selected and careless belt joining.

Battery Charging Equipment for ELECTRIC TRUCKS

THERE are now more than 18,000 electric industrial trucks and tractors in use in this country, and if we make some rough generalizations as to average use and battery size, we find that to charge them daily, an estimated amount of 150,000 kw.-hr. of electricity in the form, of course, of direct current is required. Probably most of this direct current has been transformed solely for charging purposes from an alternating supply, and if we assume an efficiency of transformation of 75 per cent, the a.c. input is 200,000 kw.-hr., which is not a negligible amount of energy.

In the early days of this industry, the purchaser of a truck would ordinarily assume that, if he had direct current available, the charging equipment would mainly consist of the wires connecting the supply lines of electricity to the battery. He had perhaps a somewhat blurred mental picture of a couple of flexible conductors and a switch.

This was not so very far from a description of the actual equipment used, though it lacked a few other essential details. In other words, the truck owner was right in assuming that the necessary equipment was not complicated or difficult to operate. As time went on, and the essentials of proper charging became more fully understood, refinement of construction took place and we now have apparatus always adequate for the particular work for which it is designed, and which varies in character and construction dependent on the answer to the one question: "To what degree shall the installation be automatic?"

A few words are now in order about both general classifications of batteries (lead and Edison) as to what happens during charge and discharge.

First as to discharge: The great value of the storage battery as a portable supply of energy lies in the fact that, as it gives up this energy, its voltage remains nearly constant and so may be compared to an undercompounded, d.c. generator. In other words, although its voltage falls off a little as the discharge increases in rate, this decrease is comparatively small, and the motors used in trucks may be designed accordingly.

During charge, a similar but reversed condition exists which means that a very slight increase or decrease in applied voltage will result in comparatively large increases or decreases in current flow. It is vital to remember this fact in connection with the design of charging equipment.

The actual internal resistance of any battery is comparatively small and the drop in voltage caused by the passage of charging current through this internal resistance is negligible compared to the drop in voltage caused by chemical changes in the active parts of the cell. This important voltage drop will have a certain value when charging starts and will gradually increase as the charge continues, reaching a maximum when no more material remains to be chemically altered or modified.

This is a roundabout way of saying that the longer you charge a battery, the higher its "voltage" becomes. At this point it is necessary to contrast the method of charge of an Edison battery with that used with a lead battery. The manufacturers of Edison storage batteries recommend that their batteries be charged at a constant current rate or approximately so, while all makers of lead cells agree that the charging rate (which in general may be any reasonable amount early in the charge) must taper down to within certain prescribed limits as the battery approaches a fully charged condition.

It is obvious, therefore, if reason-

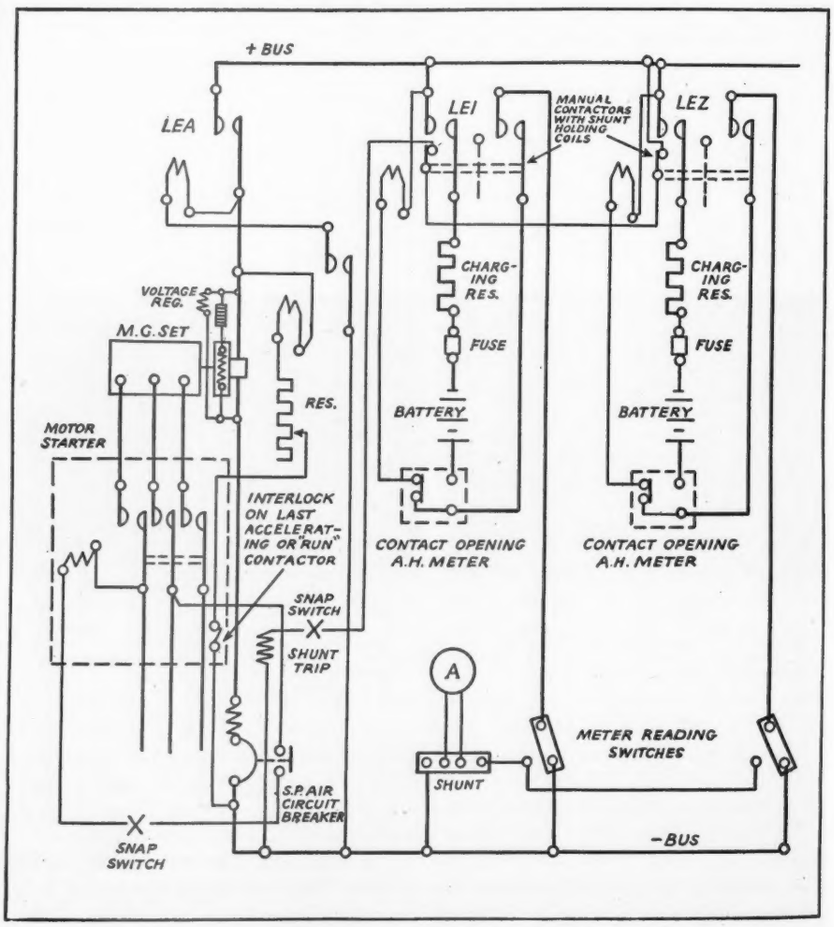

FIG. 2—WIRING DIAGRAM of a potential battery charging panel using manual contactors with shunt holding coils.

and TRACTORS

By H. M. MARTIN
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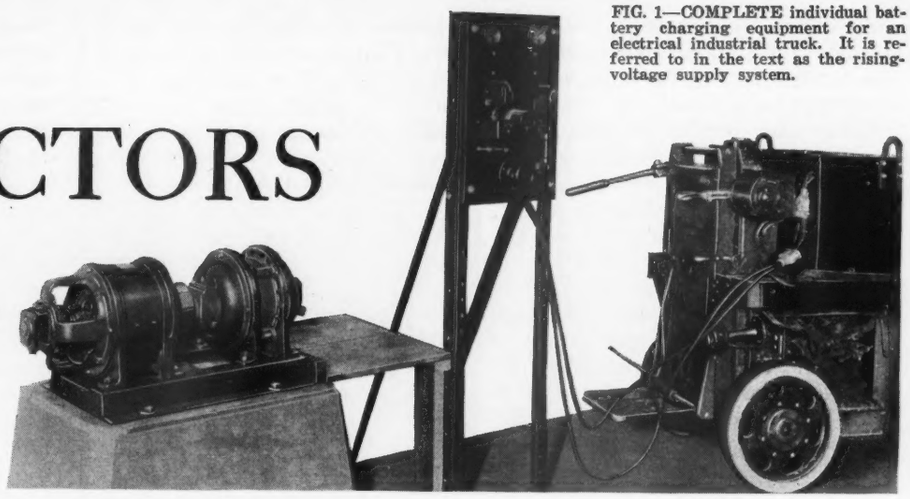


FIG. 1—COMPLETE individual battery charging equipment for an electrical industrial truck. It is referred to in the text as the rising-voltage supply system.

able amounts of current are to be handled and controlled, that this can be done in either one of two ways. Either the voltage applied to the battery as a result of which current flows into it may be gradually raised as the battery comes up, or a fixed voltage may be employed of sufficient value to finish the charge, that is, slightly higher than the maximum required at the end of charge.

The first method (the constantly rising voltage method) can only be used when one battery is to be charged. Generators are made specially for this purpose, and by a proper relation of shunt to series field they can be designed to charge a lead battery at a starting rate which is about three or four times the finishing rate, or for an Edison battery with only a small decrease in current from start to finish.

Storage batteries used in electric trucks for use on the public streets have been thoroughly well standardized as to number of cells, and one finds that, almost without exception, these will use from 40 to 44 lead cells, or from 60 to 66 Edison cells. These numbers are those best suited for charging from the usual 115- to 120-volt d.c. supply lines. Yet this very desirable standardization does not exist in the industrial truck field where a great diversity persists.

Various reasons have contributed to this condition of affairs but probably the diversity has resulted in great part from the varying requirements of truck speed. In the past it was appreciated that, for a given amount of energy it was cheaper and more convenient to use a battery having a few large cells, than to have the same capacity in a larger number of smaller cells. It is obvious that one cell having a capacity of 200 amp.-hr. will cost less than four cells each with a capacity of 50 amp.-hr. though both would produce the same energy. Assuming then a line of trucks using 12 lead cells for a speed of four miles an hour. After this has been decided upon, a special problem is presented in which the duty cycle includes repeated trips over a long route with straight runs and no severe grades—a condition where higher speed would result in economy of operation. It would be possible to use the same number of cells and a higher speed motor, but it is far easier to use the same motor and increase the number of cells, to say 16.

The great value of the storage battery as a portable source of power is due to its ability to deliver energy at nearly constant voltage. This function, however, is predicated by the type of charging equipment used. Whether you maintain one truck or a fleet this article contains first-hand information that offers possibilities for greater economy and improved operation.

The actual number of cells used at the present time by the principal makers of industrial trucks and tractors shows that the combination of lead cells are 6, 10, 12, 14, 15, 16, 18, and 24, and the combinations of Edison batteries are 10, 20, 21, 24, 28, 30, 32, 40, and 42. Also, it is not unusual to find trucks with intermediate numbers of cells. The generator voltages required to charge them are given in the table on the next page.

To group a number of these batteries in series on a standard d.c. supply of 115 or 230 volts would be an acceptable method were it not for the fact that actual operating conditions result, at the end of a day's work, in batteries in all conditions of discharge, some fully discharged and others only partially so. If such batteries are grouped at random in series, all will have to take the same total ampere-hours of charge and some will be over-charged, resulting in undue depreciation. It is for this reason that series charging, though used here and there, is not considered the best procedure. Therefore, it is necessary to use voltages to suit this varying number of cells as shown in the accompanying table.

In this table there are sixteen voltages, and the makers of charging equipment may be called upon to make prompt shipment on motor-generator sets varying in capacity from 50 to 3,000 amp. or more.

Obviously, these varying ratings cannot all be stocked and so the manufacturers of charging equipment each decides on generators nominally designed for perhaps four or five spaced voltages, but capable of modification up or down in voltage to cover the complete range.

As an example one might pick 15, 32, 45, 55 and 70 volts as so-called standards, and then fill in the gaps

with derivatives from these. So much for the voltage requirements as necessitated by the varying number of storage battery cells.

Going back to the practical problems involved in the charging equipment, one finds that the choice of apparatus will depend on quite a few constants and one variable. The constants are:

1. Number of trucks.
2. Number of battery cells, and number of plates per cell.
3. Kind of power supply; (*a*) If direct current, the voltage; (*b*) If alternating current, the voltage, frequency and number of phases.
4. The maximum time available for charging.

The variable is the amount of attention that can be devoted to the charging equipment during charge.

Where only one truck has to be charged (and it is customary not to use the more exact expression of charging the battery), the general practice is to use the type of equipment shown in Fig. 1 and referred to as the rising-voltage system.

TABLE—NUMBER OF CELLS AND CHARGING VOLTAGES

Lead	Edison	Even Volts Nearest
6		16
	10	19
10		26
12		31
14		36
	20	37
15	21	39
16		42
	24	44
18		47
	28	52
	30	55
	32	59
24		63
	40	74
	42	78

turns slowly to the zero or fully-charged position and at this point a contact is broken which results in the disconnecting of the generator from the battery and the shutting down of the motor-generator set. It may readily be seen therefore, that the successful operation of this type of automatic charging equipment depends on the reliability of the ampere-hour meter which, during the past few years, has been brought to a high state of perfection.

To maintain any battery in good working condition, it is necessary to put into it on each charge slightly more ampere-hours than have been withdrawn on the preceding discharge. This function, the ampere-hour meter controls automatically since, during discharge, it indicates true ampere hours, but during charge, it runs slow by an amount capable of regulation. The percentage of overcharge may, therefore, be predetermined.

It was stated previously that with all physical conditions known; battery size, power supply, etc., the choice of charging equipment would depend on the amount of attention that could be given to the equipment while in use. This statement should be qualified by the assertion that the most modern practice leans, wherever practicable, to a charging system which is completely automatic. This is merely another way of saying that, in the long run it is better, cheaper and safer to rely on well designed automatic devices than on human judgment.

The Electric Industrial Truck Manufacturers' Association has codified the features of control which are desirably automatic, and the list is as follows:

1. Automatic independent cut-off for each battery when fully charged.
2. Automatic shut down of the motor generator when the last battery has cut off.
3. Automatic shut down of the set in case of a line interruption.
4. Automatic restart of the motor generator upon return of power supply following an interruption.
5. Automatic control of the charging rate by the modified constant voltage or the constant current system.

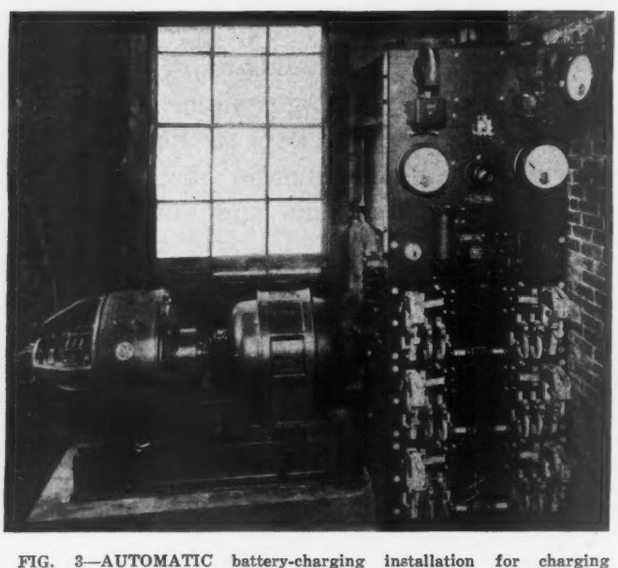


FIG. 3—AUTOMATIC battery-charging installation for charging six electric trucks in a Lynn, Mass., laundry. It consists of a generator and a motor-control section at the top; and three two-circuit sections below. Lamps are used on each circuit to indicate that proper connections have been made to the batteries.

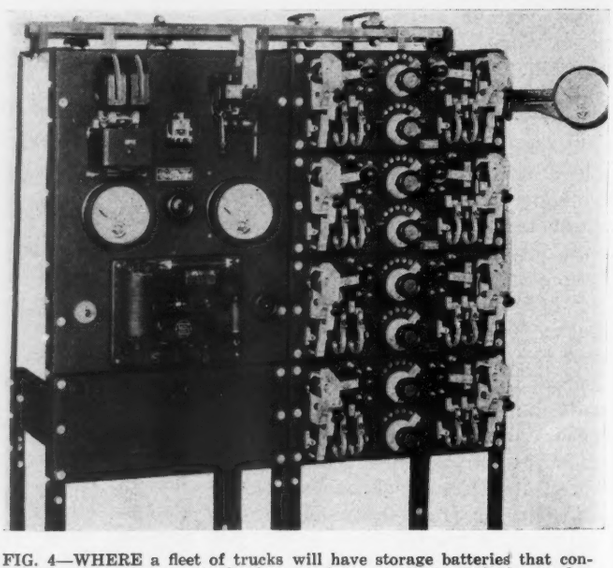


FIG. 4—WHERE a fleet of trucks will have storage batteries that contain the same number of cells, but varying in capacity with the number of plates per cell, any one of the batteries may be properly charged with this type of equipment. It is an eight-circuit battery charging control panel.

Alternating current supplies power to a motor which drives a d.c. generator controlled by the devices on the small switchboard. These devices are very simple, and include primarily, a contactor which connects the generator to the battery when its voltage is high enough. The truck carries an ampere-hour meter (not shown) having an indicating hand which shows the condition of discharge of the battery. During charge, the indicating hand of the meter re-

In addition to these automatic features, the association recommends that generators designed for constant voltage charging shall comply with certain specifications, the most important one being that, "under practically all conditions of operation the voltage shall not depart more than plus or minus 3 per cent from the desired voltage."

This can be accomplished in two ways: (1) Either by making the generator with a comparatively large frame, low-heating and a very careful balance between shunt and series winding, or (2) by the application of a voltage regulator to the usual type of flat-compounded generator.

Other details will be apparent from an inspection of the diagram.

This system, while shown for operation with contact-breaking, ampere-hour meters, will, of course, function just as well with contact-making meters. With contact-making meters the cut-off of each battery is accomplished by the short circuiting of the contactor holding coil, instead of opening it.

Fig. 3 illustrates a completely automatic equipment as outlined above for the charging of six trucks. It consists of a generator and a motor-control section at the top; and three, two-circuit sections below. In operation, the indicating lamps on each switch. Any one of the eight batteries may therefore be charged on any one of the eight circuits and get the proper current.

The control systems so far illustrated and described have been completely automatic. Where the conditions of operation justify it, some of the automatic features may be dispensed with. A typical case is that of a steamship pier near New York where a large fleet of industrial trucks must be ready day and night for handling freight. A careful analysis of operating conditions showed that a 20-circuit charging equipment could keep the trucks going. The control shown in Fig. 5,

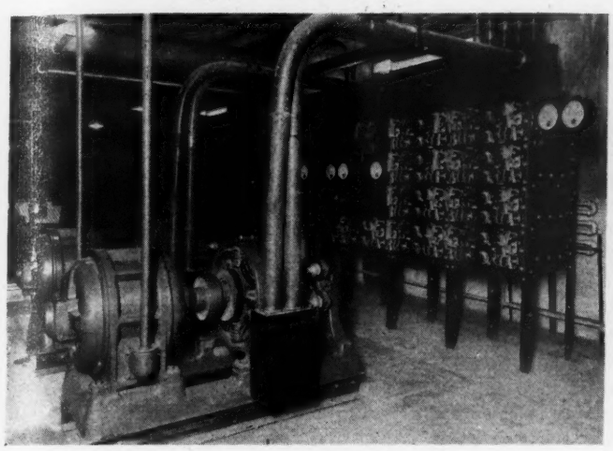


FIG. 5—MOTOR-GENERATOR SETS and switchboard of a 20-circuit charging installation that keeps a large fleet of trucks moving in a large terminal. It has a capacity of 30 Edison A6, 21-cell batteries.

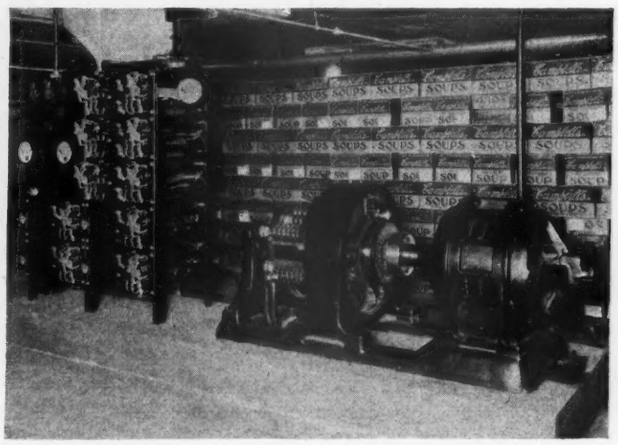


FIG. 6—BATTERY CHARGING EQUIPMENT for 10 electric trucks used in a large supply house in Boston, Mass. The synchronous motor driving the generator is used for power factor improvement.

Uniform voltage is vital to successful charging, either automatic or manually controlled. In approximate figures and referring to lead batteries, the starting current will rise 5 per cent for each per cent rise in voltage above the desired voltage; and the finishing rate will rise 10 per cent. It will be seen, therefore, that the plus or minus 3 per cent limit is about as much as can be allowed.

In order to perform the automatic charging functions recommended by the Electric Industrial Truck Manufacturers' Association, various systems of control have been devised, one of which is shown in Fig. 2.

Without going into this in detail, it should be noted that its salient features are: (1) That the contactors in each battery circuit hold in until the end of charge. (2) That, in the event of a power failure, the generator contactor comes out before the d.c. voltage dies down. (3) That, when the last battery comes off, the over-current circuit breaker is tripped and this opens the holding circuit of the motor starter, permanently shutting down the set.

circuit show that proper connections have been made to the batteries; the generator circuit breaker is closed; the snap switch starts the motor generator set, and, when the generator voltage rises to the proper value, the main contactor closes and the voltage regulator insures close voltage regulation. Each battery circuit contactor is then closed and charging starts, each battery taking a current dependent upon its needs.

In modified constant-potential charging, all batteries of the same size require the same single step of resistance interposed between the d.c. line and the battery. Quite often, however, a fleet of trucks will have batteries all having the same number of cells, but varying in capacity with the number of plates per cell. This condition is easily taken care of by the type of control shown in Fig. 4. In this case there were eight batteries, all with the same number of cells but of six different ampere-hour capacities. In each of the battery charging circuits there is a portion of the resistor which is regulatable by the six-point dial

was installed and, during the rush periods of work it is in the care of an attendant, who puts exhausted trucks on charge as fast as they come in. He determines by a reading of current and voltage when they are again ready for work and turns them over to the truck operators.

This control automatically maintains constant potential within close limits and leaves the other details of charging to the attendant. Each of the twenty charging circuits is therefore very simple and, to put a truck on charge, it is only necessary to close the double-pole switch. The two single-pole switches are used when necessary to cut out a small portion of resistance for boosting, and to secure an extra low finishing rate to be used at stated intervals.

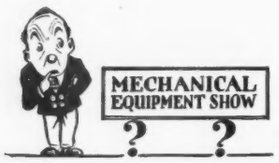
Many other detail changes in the modified constant-potential method of charging are feasible. Indicative of this, is an installation shown in Fig. 6 for a leading grocery supply house that includes a set with a synchronous motor (for power factor improvement) and a ten-circuit panel.

Plant Engineer's

Conducted by F. M. GIBSON, *Consulting Editor*

Plant Engineer at American Sugar Refining Company

THE annual power show in New York last year was somewhat different than those of previous years and it seemed to be as popular as ever. The major difference was the absence of a number of manufacturers of power equipment and the presence of manufacturers of mechanical equipment. It is rumored that the exhibitors of power equipment prefer to exhibit every other year and several engineers have suggested alternating the power show with a mechanical equip-



ment show. It is reasonable to believe that no steps in that direction will be taken until some demand for a mechanical show is expressed.

* * * *

The industrial engineer has or should have a decided interest in this subject and ought to make his position known. If you want a mechanical equipment show to replace the power show every other year, why not write to the Forum and express your opinion? If you will do your part by providing a substantial expression of opinion, I will guarantee that it will be placed before the management of the show.

* * * *

The mechanical department of every plant has a mental attitude; you can always find it if you look for it and often when you do not look for it. Also you will invariably find that it is very much in tune with that of the engineer in charge. When visiting a plant you will sometimes see the men working with a nervous worried manner that indicates an irrational supervision or one that is not always just. Then again as one passes along he notices furtive glances from the men that usually means one of two things. It may mean that the men are surly, expecting little consideration from the boss and being prepared to give as little in return or it may mean idle curiosity and that as soon as the white collars have passed on considerable time will be spent in discussing who the visitors might be and what the visit portends.

It is a pleasure to enter a plant and to see the employees continue with their work without any undue curiosity or change of pace. They are engrossed in their work but show no signs of being harassed. Such an attitude comes only from the consciousness that they are doing their work well and that it will be judged on its merits. Such a condition speaks volumes for the supervision. If you wish to gage the mental attitude of your department, just notice the glances and actions of your men as you pass through the plant.

* * * *

Welding in industrial plants is rapidly approaching that status which salesmen like to describe as a condition when it is not a question as to whether you can afford it but a question as to whether you can afford to do without it. Welding has not solved all of the problems but it has solved a sufficient number to make it a big time and money saver. One must admit that today a weld is made that is stronger than the material on which the weld is made. When welding first came on the market we justly called the weld a casting. It is still a casting but a casting with a great deal of ductility. It may not have the ductility of the rolled iron plate but it has sufficient and if there is a failure it will be somewhere else than in the weld. The alloy rods have produced results that are fast driving out the prejudice of industrial engineers.

Many plants are just starting, doing small maintenance work by welding while others have passed beyond that stage and are making welds in parts subjected to great strains and that operate at high speeds. Some plants are specializing on pipe work and securing very good results. One concern which manufactures its own production machines began welding the machine frames. This proved so profitable that the machine parts where designed to be welded and a large saving in weight as well as further labor saving was secured. The weight in the redesigned parts and the labor in putting those parts together have been reduced 70 per cent. Naturally they are very enthusiastic about it. It is impressive to see the limited and timid way in which a plant starts welding and how rapidly its use spreads over the entire plant.

The technical side of welding is on very firm ground. If a competent welder states that certain jobs can be satisfactorily done there is no question but that the material can be welded and that the welding rod will produce a weld stronger than the material welded. It is also true that a good weld will be obtained if it is made by a competent man and that is where the problem comes hardest on the industrial plant. The industrial plant that goes in for much welding should have its own welders.

Calling in contractors for the general run of plant welding is expensive and in emergency cases much valuable time may be lost before the contractor arrives. I saw an instance recently where a plant called in a contractor to weld some steel frames in ash hoppers. The engineer admitted that he could have strapped and bolted the frames for less money than the contractor charged but he also stated that if he had had a welding crew of his own he could have

Forum

welded the job cheaper than by strapping. But to develop one's own welders requires time. Usually it is not satisfactory to bring experienced welders, most of whom are engaging in contract work, into an industrial plant. It is not always possible to keep them supplied with work and they are either not competent or temperamentally agreeable to do other work. As a consequence they become dissatisfied and are apt to spread their dissatisfaction to others. It is much better to break in one's own welders even though it is a slow process. It takes time for the apprentice to accumulate experience and for the engineer to gain confidence in the ability of the apprentice. The time will be considerably shortened if the apprentice is sent to some place where instruction is given. In the meantime, contractors can be used for maintenance welding. Care should of course be taken in selecting the apprentices.

* * * *

My preference is for a clever and dependable young machinist who has had experience in maching different metals rather than for an ironworker, a tinsmith, a pipefitter or a coppersmith as some have chosen. One engineer remarked recently that it would not be long before the pipefitters would all be replaced by welders. I would hesitate to say as much as that but there is no doubt but that the next few years will see a tremendous increase in the use of welding in industrial plants.

* * * *

The difficulty of finding figures to express comparative values to the laymen is well illustrated by a recent experience of a New Jersey engineer. It was decided to humidify the air in a large room and both steam and water were available. The manager for some reason desired to spray steam into the air and the engineer recommended water as being more economical since it did not involve the waste of heat.

The manager wanted to know how much heat cost and was told that 1,000,000 B.t.u. cost 30 cents. He could not see that water was cheaper because it cost $1.00 for only 1,000 cubic feet. It took a pencil and some time to convince him that the heat in the steam was worth almost

20 times the cost of the water and that the same amount of water would be used in either case. The manager is a very successful man but the large number misled him. That is one reason why the engineer is not always understood.

* * * *

A number of years ago there was a very serious effort made to create a method for specifying lubricating oils. A large committee consisting of the best talent among the oil refiners, equipment manufacturers and operating engineers labored long and earnestly to eventually produce what they considered a successful solution. At the meeting when the final draft was unanimously approved, the chairman asked all of those who were willing to use on their capital equipment oils purchased by specification without preliminary trials to raise their hands, and not a hand was raised. It was the last meeting of the committee. The subject of specifications was "washed up" and will probably stay so for some time to come.

Specifications can be of little value unless the material under consideration will give a definite performance under given conditions and this is especially true of lubricating oils.

It is not to be argued that nothing is known about the subject we are discussing. Although all of the mystery has not been solved, much has been accomplished and more will be when specifications can be written. There are oils that one can select and be confident that they can be applied safely, but such oils are not the most economical. Some engineers seem to sleep better at night when they are using expensive oils but they are sometimes spending too much for personal comfort. On the other hand:

One time I attempted to use a cheaper grade of oil on some centrifugal machines. The oil selected was tried on one machine and carefully observed. Gradually all machines were lubricated with this oil. Unfortunately the change was made in cold weather and was so cautiously made that the change required three months. In June there occurred an unusually warm spell that lasted a week and three of the machines burned out their bearings at a cost of $180. One can not safely adopt the use of an oil until he has tested it in service under the severest conditions. This means conditions of heat, load on equipment, method of operation, changes in the materials handled by the equipment and sometimes the character of the oilers. It is advisable in many cases to determine the amount of friction. It is good policy to test the oil on one machine where a failure will not be serious, and then gradually on more machines. In order to secure the most economical oil this procedure must be repeated with each oil that is tested. It is a long and tedious job but it is the only safe method of determining the oil.

* * * *

It is a very healthy thing to have your work reviewed by some one else before putting it into effect but one becomes so immersed in a job that he neglects to do so. The subject of industrial safety has always appealed to me and it was not an

unpleasant experience to be asked a few years ago to get up a pamphlet of some 50 general rules of safety to be given to the employees for their guidance. It was very illuminating a little later to have an employee in a slogan contest suggest the following: "Obey all rules of safety—the rules of commonsense as well as those of the company."

INDUSTRIAL ENGINEERING

Electrical, Mechanical and Plant Service in Industry

L. C. MORROW, *Editor*

Chicago, April, 1929

The Push-the-Job Man

ALWAYS push the job—don't let the job push you. This piece of wholesome, concentrated advice was the burden of a managerial call-down directed at a young man who was a good worker, but inclined to wait for his duties to make themselves evident. The young man joined the push-the-job ranks, to his ultimate advantage and lasting satisfaction.

In the industrial plant there are many service-to-production jobs that can be pushed. Replacing parts before breakdown is one of them. Protecting surfaces by paint is another. A third is lubricating in advance of wear.

Still another is cooperating with the engineering departments of the plant and the equipment manufacturers to prevent recurrence of equipment failure. To illustrate: Part of the mechanism of a steel rolling mill broke. Within fifteen minutes the maintenance crew had men from the engineering, design, and metallurgical departments on the job. Within a short additional time the causes for the break had been determined and this information was on the wire, traveling to the equipment manufacturer. In the meantime the part had been replaced and production resumed. This particular break could not have been foreseen, but the push-the-job men in the plant did foresee the possibility of a like break in the future and lost not even a minute in doing all they could to prevent it.

It's keeping the plant going that is the objective of all of its personnel—in the departments of management, sales, production, maintenance. No department offers more opportunity for really getting results by pushing-the-job than is afforded in the maintenance department.

Design Guards to Increase Production

DESIGNING mechanical guards is a man-size proposition. Too often it is considered a rather lowly task, something like a necessary routine job. It should be looked at differently—first as an opportunity to serve industry in the prevention of loss of man power, and second as an opportunity to exercise real design ability.

Many must be the benedictions showered upon the heads of the men who have designed press guards that sweep or pull the operators' hands away from the dies before harm can befall them. It must be with a spirit of thankfulness that the operator contemplates what might have happened but for the well-designed guard.

Perhaps the guard of the metal-working press furnishes the most spectacular example of the conservation of man power by guarding. Other machines in the metal-working industries and many kinds of equipment in all industries provide plentiful opportunity for protective guarding, even if not spectacular.

Guards that are really efficient make the operator feel safe; consequently he does not devote undue time and attention to the process of keeping out of harm's way. He goes ahead and works. The net result is an increase in production.

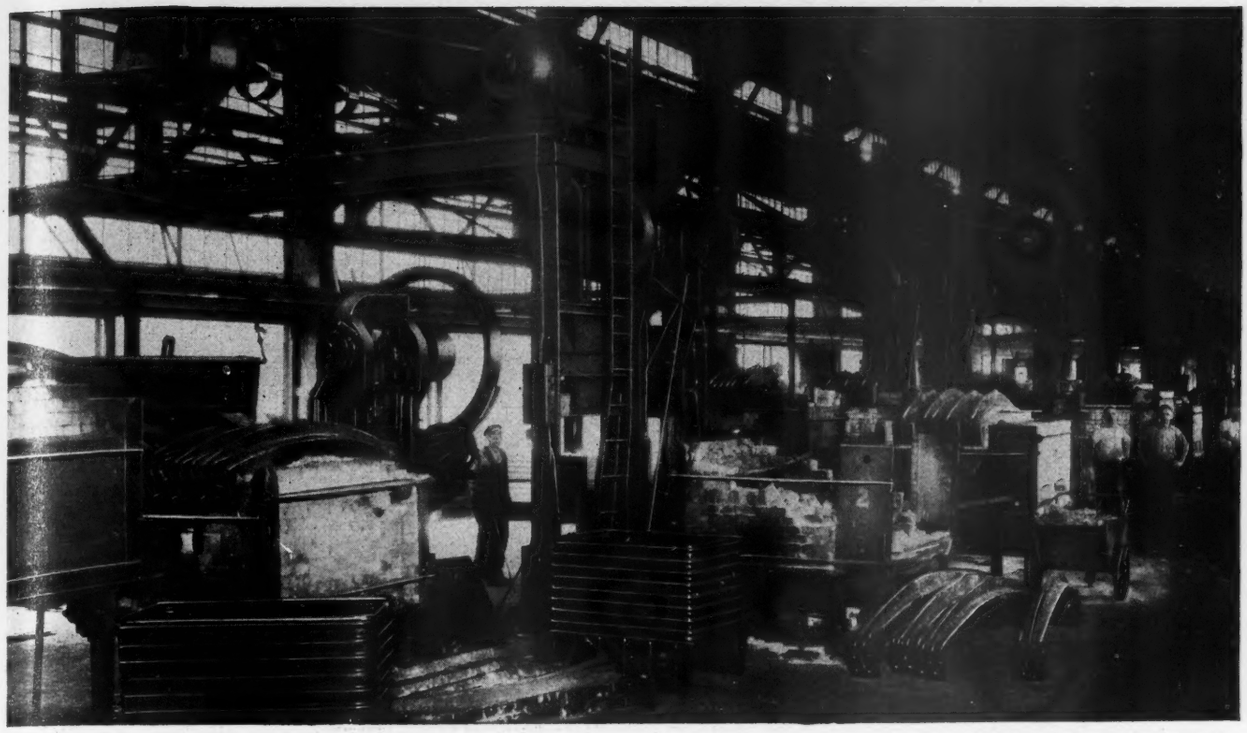
Efforts to make industrial occupations safe have increased tremendously during the past ten years. So have the results achieved. The time has not come, however, when the men responsible for safety can sit back and feel that their job has been completed. They must enter the refinement stage now, designing their guards as factors to increase output as well as to conserve the workers. To acquire the right frame of mind for this phase of the work they must recognize that the work they are engaged in is a man-size job.

Spare-Part Stocks Are Insurance Against Breakdowns

ON the books of the accounting department the cost of spare parts for the electrical and mechanical equipment in a plant are carried as part of the capital investment. From the standpoint of the secretary or auditor that classification is entirely satisfactory. From a practical viewpoint it is misleading, a fact that may help to explain why some managements are so reluctant to permit the maintenance department to carry an adequate supply of parts in stock.

Actually, spare-part stocks are the most effective form of insurance against breakdowns and production delays, and should be so considered. And yet, many plants that would not consider for a moment letting a fire insurance policy lapse, will operate year in and year out with little or nothing between them and a costly shutdown except the ingenuity of the maintenance and repair crew. Fortunately, that ingenuity is seldom lacking when an emergency comes, but even it cannot create new coils, or bearings, or whatnot, merely by a wave of the hand. Hence, until the needed parts can be produced or made up, the output of an important machine or department may be reduced to zero.

If the value of the hourly or daily production of a machine or department is calculated it will usually be found that it is many times the cost of a well-selected stock of parts that would entirely eliminate shutdowns due to failures of equipment, or at least limit them to short duration.



ONE of the hammer groups. The motor drives a 5,000-lb. line shaft pulley, which also serves as a flywheel to smooth out the load peaks.

Mechanical Refinements of

Group Drives

Improve Operating Conditions

THE GROUP METHOD of driving board drop hammers is generally accepted as the best practice from an economical and a practical standpoint. There is, however, considerable latitude in the idea for the exercise of ingenuity in devising ways and means of reducing power requirements, and improving operation generally. For instance, the adoption of some method for smoothing out the excessive peak loads characteristic of hammer operation relieves the driving equipment of considerable strain, and thus prolongs its life. The same is true, of course, of the friction load: the greater the extent to which this component can be reduced, the more efficiently and economically the drive will operate. An example of what can be done along these lines that possesses several interesting features is furnished by the drive system employed in the forge shop of Dodge Brothers, Inc., Detroit, Mich. Aside from the operating results that have been obtained, the installation has several novel points mechanically, among them being the use of roller bearings on the main driving shafts.

Before going into a discussion of the results that have been accomplished, a description of the drive system itself will follow. The complete installation consists of 19 hammers ranging in capacity from 1,200 to 4,000 lb., arranged in two facing lines the length of the shop. For driving purposes the hammers are divided into groups of five, of uniform capacity, each group being driven from an individual overhead line-shaft which is in turn belt driven by a 440-volt, squirrel-cage induction motor. The rated capacities in each group have been selected so that the maximum load on the shaft does not exceed 6,000 lb., even though the total rated hammer capacity may exceed this amount. The arrangement was made possible by the fact that the peak loads are practically never in synchronism, and the mean load is generally well within the limit set. Thus, it has been possible to group five 1,200-, five 1,600- and five 2,000-lb. hammers on separate shafts, and three 2,000- and one 4,000-lb. hammers on another shaft.

The shafts themselves are practically uniform in length and diameter, the length averaging about 85 ft., except in the case of the 2,000-lb. hammers, where the length is 106 ft. The shaft diameters are all in the

neighborhood of $4\frac{7}{16}$ in. The motor horsepower varies with the hammer capacities, being 50, 75, 100 and 100 hp., respectively. The motors are equipped with push-button compensator control, the control being provided with selective overload protection, that is, the overload device will discriminate between useful overloads, and abnormal power conditions. The shafts are run at a uniform speed of 220 r.p.m., the reduction from motor speed being obtained by the belt pulley ratio.

One of the interesting features of the installation is the use of 5,000-lb. fly wheels as main shaft pulleys. The fly wheels are mounted on short individual shafts coupled at each end to the driving shaft, and supported by two Dodge-Timken pillow blocks, one on each side of the wheel. The shafts proper are also supported by blocks of the same character, located on each side of the hammer drive pulleys. By virtue of this arrangement the shafts are supported about every eight feet. The weight of the shafts and pulleys in each case was such that the use of shaft hangers was impractical, therefore the supporting blocks are mounted on brackets which project from heavy columns extending from the floor to the roof supporting structure.

The performance of the system, as far as operating effectiveness and economy is concerned has developed some interesting phases. With regard to power consumption, the liberal use of roller bearings, coupled with the flywheel effect of the shaft drive pulleys has resulted in reducing and stabilizing the power demand considerably. Another advantage that is directly traceable to the use of the bearings is the improvement in the overall power factor conditions of the installation. Under ordinary circumstances the shafts would have to be overpowered to take care of heavy starting loads, and operating peaks, to a point where the power factor during normal running would be very low. As it is, with the reduction in the starting load, and the practical elimination of peaks, the motor ratings correspond so closely to the normal running power demand that the power factor is well up, around 85 per cent, to be exact. Such an advantage is of material value in a case of this sort, and in any similar case where the power consumer is penalized for poor power factor.

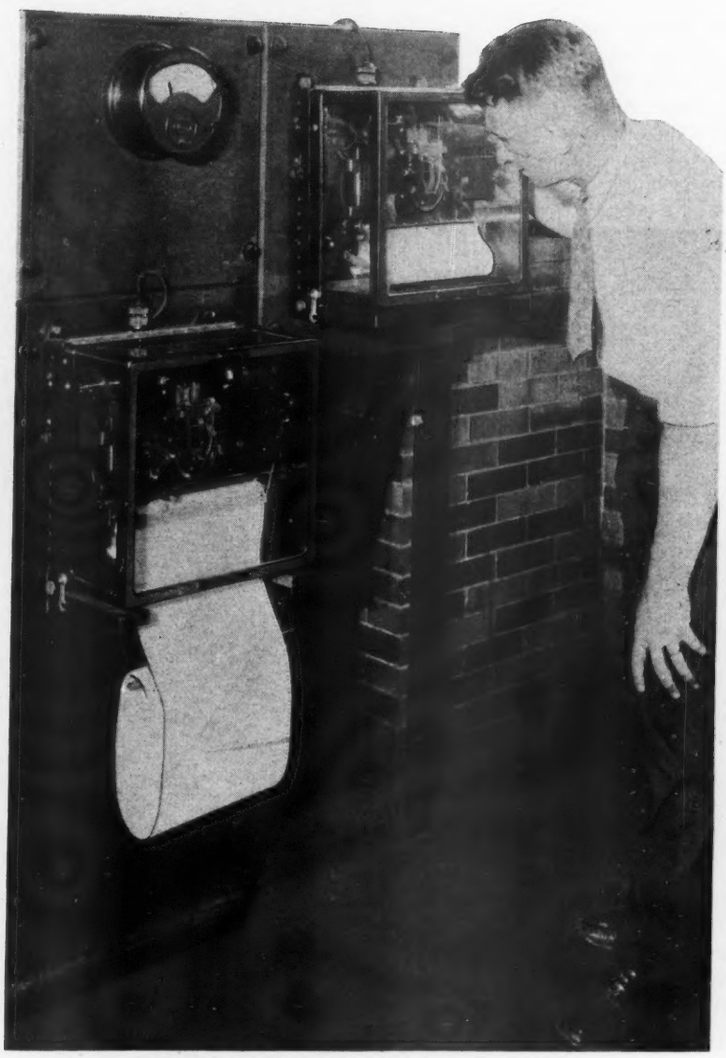
The lubrication question has also been considerably simplified. The ambient temperature of the building at the level at which the bearings are installed is sometimes as high as 185 deg. F., due to heat radiation from the furnaces, and the work itself. This, usually, would complicate the lubrication problem quite a lot; both inspections and renewals would of necessity be very frequent. Considering the location of the bearings, both processes would be expensive, not to say inconvenient. Under the present system, it is only necessary to renew the lubricant about once a month, and frequent inspections have been done away with. It is also found that shaft trouble due to misalignment has disappeared. This is a worth while consideration, as misalignment of shafts in an installation of this sort usually results in a broken shaft, almost immediately. In fact, to sum up the whole matter, practically every phase of operation and maintenance has been improved by the mechanical refinements adopted.

LAYING out power drives for operating heavy drop hammers presents some interesting problems that are not always easy to solve. The manner in which these problems were solved in a particular installation that embodies some unusual features and has shown splendid performance are discussed in this article.

GENERAL VIEW of the hammer shop. The method of mounting the motors and line shaft is shown at the right.

Checking the Distribution of Purchased Power

By K. D. HAMILTON
Plant Engineer
Geo. D. Keith Company
Brockton, Mass.



STRIP RECORDERS, permanently installed, afford a ready means of obtaining operating characteristics of the plant equipment at a glance. When checked against integrated readings, apparent discrepancies in the consumption can be easily explained.

WHETHER the monthly statement for power consumed represents a monetary obligation or just an inter-department bookkeeping charge, there is much to be said in favor of it aside from the regularity of its receipt. It is useful for three main reasons. In the first place it provides a means for the management to compare operating costs. In the second place it enables the plant engineer to compare operating characteristics, that is, whether the maximum demand has been exceeded or if the penalty for poor power factor conditions has been applied. The third reason, and one that is usually overlooked, is that it prompts an investigation of the distribution of the power consumed.

In this case it means more than the checking of the incoming meters which register the total incoming power because the power company usually has accurate metering devices to check the flow of current to their customer. In some cases the customer does little to check his records except to accept the bill as final.

However, the plants with few applications, or the plants having a distribution system for lighting only come under this classification, but only where the character of the product and equipment necessitates a complicated distribution system is the means for checking the distribution of power emphasized.

Many plants make a practice of reading their meters weekly to obtain a check on the power consumption in all departments, whereas others go to extremes. In one case two daily readings are taken; one A. M. reading before operations begin, and one P. M. reading after daily operations have ceased. The difference between these two readings represents the consumption for that day's production, whereas the difference between the night and morning readings gives the consumption during the night. These daily readings are compared against the day's output in production units, thereby providing comparative figures for the records. The grand total of these figures for the day and night periods is then checked against the monthly statements. Any discrepancy between the totals involved can be traced to the department in which a wide variation in consumption was noted.

If the operating conditions of the department under consideration have not changed, during that period, it is quite evident that an exhaustive investigation will be ordered to determine the facts. Thus, it is seen that the last reason is of utmost importance to the plant engineer.

The other extreme is where a plant regardless of its size ignores the importance of meter reading except at the end of the month. These monthly readings being required only to determine the year's total consumption by months.

Yearly comparison of kilowatt-hour consumption when properly analyzed will furnish valuable mate-

rial for estimating purposes because it provides a means of obtaining the unit cost of power as against production cost per unit of product.

However, it is much easier to determine operating efficiencies in the different branches by checking the unit cost of production each week and to draw conclusions as to motor efficiency, friction losses and general operating conditions.

Meter reading presumes the installation of meters in all important circuits of the distribution system.

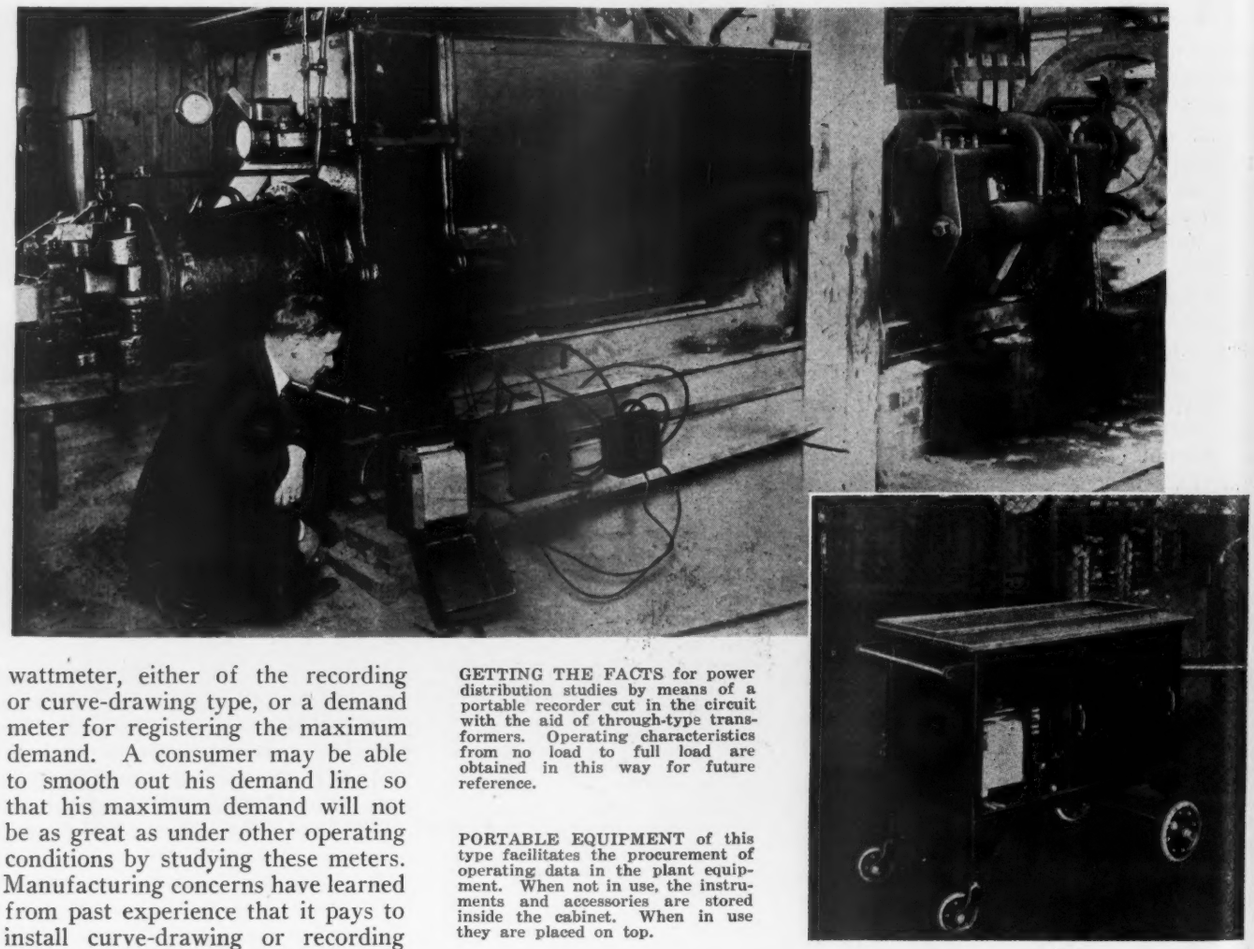
The substation or main incoming panel is always equipped with a kilowatt-hour meter, and sometimes a wattmeter, either of the recording or curve-drawing type, or a demand meter for registering the maximum demand. A consumer may be able to smooth out his demand line so that his maximum demand will not be as great as under other operating conditions by studying these meters. Manufacturing concerns have learned from past experience that it pays to install curve-drawing or recording instruments. The curse of an argument and the resulting ill-will can be obviated when positive proof is available. For this and other purposes, the records are invaluable as they enable the engineer to study load fluctuation, to iron out peak loads, and to arrange starting conditions so that the demand for current does not come at one particular time.

The tendency of the average industrial plant is to throw all motors on their lines at one time. This will have the effect to increase fuse trouble, create excessive copper losses, and build up their peak demand which tends to increase their power bills should they be operating under this type of rate.

Another factor that bears watching and which can only be checked up carefully through the use of instruments is that of power factor. If a company is operating on a power-factor clause, it is very important that this information be obtained as a part of the contract for purchase power. They should obtain this information purely for their own interest to see that their power factor is maintained at a maximum in order to reduce copper losses and line losses which occur in a plant having high inductive capacity. By checking up the energy consumption together with the values of current and voltage at the indicating meters in the various phases, information can be obtained so that the power factor can be accurately calculated without the necessity of an expensive power factor meter. Power factor readings should be taken to obtain data for accurate computation at least once a month.

The larger industrial plants usually have a distributing switchboard located at some central point in the institution, such as the engine room or other location for distributing the power to the various factories. An incoming panel is usually controlled by an oil switch which may or may not be equipped with kilowatt-hour meters because the power company provides this equipment at their end of the line. In addition to this incoming panel there are control or distribution panels for the distribution of the power and lighting circuits to the various buildings. These panels usually control the high-voltage circuits to other distributing centers within the plants, and may or may not be equipped with metering devices. It is considered good practice to deliver the power at higher voltage to the various buildings and transform it at each individual unit, so as to keep the copper sizes to a minimum and likewise, the initial investment.

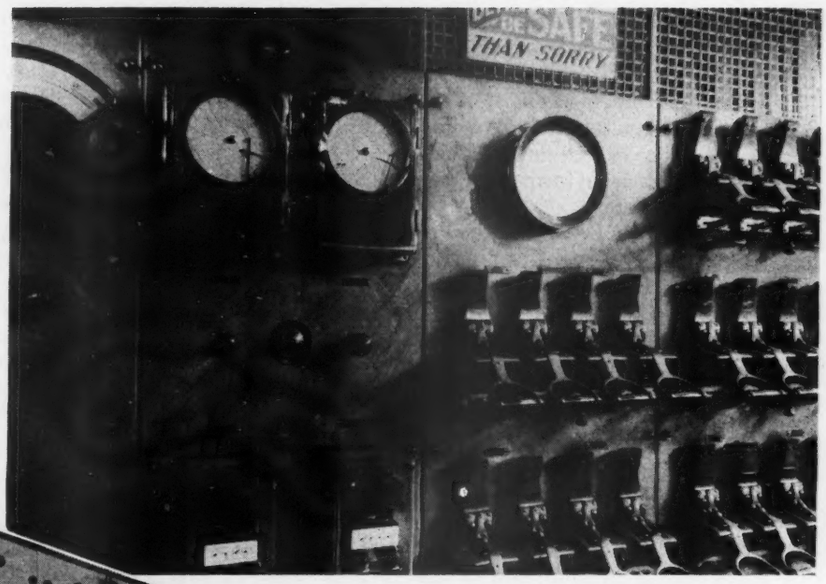
It usually follows that when the control panel in the substation is not equipped for metering the consumption of the circuit that it controls, the incoming panel or the distributing



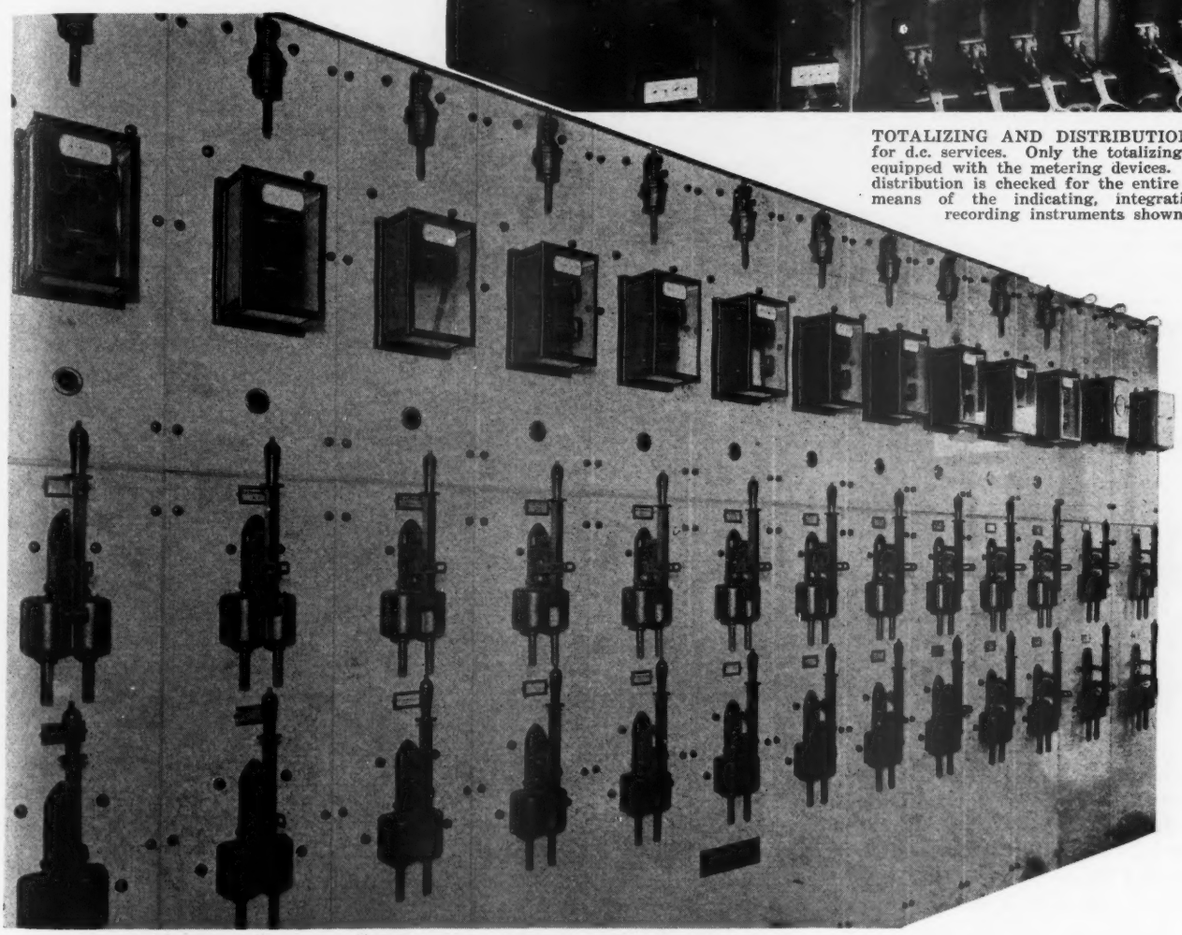
GETTING THE FACTS for power distribution studies by means of a portable recorder cut in the circuit with the aid of through-type transformers. Operating characteristics from no load to full load are obtained in this way for future reference.

PORTABLE EQUIPMENT of this type facilitates the procurement of operating data in the plant equipment. When not in use, the instruments and accessories are stored inside the cabinet. When in use they are placed on top.

panels at the distribution center will contain the necessary equipment. This equipment usually consists of an indicating wattmeter, a volt meter, a kilowatt-hour meter, and ammeters in the various phases so that the operating engineer may tell at a glance the power consumed in any particular circuit as well as the energy demand at any particular time. The indicating instruments furnishes data for operation. The



DISTRIBUTING CENTER for a.c. services. Each panel is equipped with a totalizing meter to record the energy consumed in the various departments served.



TOTALIZING AND DISTRIBUTION panels for d.c. services. Only the totalizing panel is equipped with the metering devices. The d.c. distribution is checked for the entire plant by means of the indicating, integrating, and recording instruments shown.

kilowatt-hour meter furnishes an opportunity to pro-rate the power charges to each individual building, depending upon the total amount of power consumed.

By checking the total readings of all kilowatt-hour meters on the board with the master meter in the substation, some idea may be obtained as to the accuracy of the various meters, although it is good practice to have all meters tested at least once a year because of the operating conditions which might throw them out of adjustment. Flexibility of control and the simplicity of studying operating conditions are only possible when each individual factory is equipped with an incoming and totalizing panel as well as with redistribution panels in that particular unit when the power is being distributed from the main plant, boiler room or power house.

These distribution sub-panels in the various factories are duplicates of the main distribution panel, having an incoming meter for the lower-voltage distribution circuit to the mill itself. These circuits may be at 110, 220, or 550 volts depending upon whether the service to be used is for power or lighting. Here again, kilowatt-hour meters as well as other indicating instruments, such as the wattmeter, voltmeter, and ammeter furnish very necessary equipment for the operation of the particular mill, provided that the cost of power is charged accurately to all departments.

In addition to the foregoing we have found from our own experience and it can be applied to other industrial plants as well, that test instru-

ments for checking up on the equipment in the plants are very necessary items of plant equipment. These test instruments consist of an indicating wattmeter, a voltmeter, and an ammeter as well as the necessary instrument transformers which go with these meters for testing the higher voltages of a.c. circuits. For d.c. work, this equipment consists of a voltmeter, a wattmeter and an ammeter or a millivoltmeter with the necessary shunts. These instruments are invaluable for observing motor operation. They provide a means of determining the operating efficiency of the equipment and by their use detect impending trouble. For instance, many times fuse troubles develop where it is otherwise impossible to actually determine the cause. By checking the consumption of this motor with testing instruments, it is frequently possible to point out the difficulty and remedy it without much further trouble. Then again, on lighting circuits the instruments prove invaluable. It is necessary to check voltage drops to be sure that the proper voltage is obtained at the light.

After discussing the various instruments that are required by the average industrial plant for the purpose of checking the distribution of power, we come to the system of prorating power cost among the different departments. First, we start off with the master meter reading in the substation. This monthly statement is checked against the meter reading for accuracy and total charges. We desire to pro-rate this statement among the various factories. Because we have the kilowatt-hour readings of the monthly consumption in any particular building, we can pro-rate this bill in accordance with the kilowatt-hour consumption in that particular factory. This may be charged up as power or light. If we have kilowatt-hour meters on our light circuits as well as our power circuits, this information is readily obtained by taking the percent of the bill which applies to the kilowatt-hour consumption in that particular building and figure it on a dollar basis.

After we have decided upon the total kilowatt-hour (power and light) charge against any particular factory, we then decide to divide this individual bill or factory charge into departments. Here again, the distribution panel in each individual factory comes into play and by arranging the circuits in the various factories so that each department is on a separate meter, it is possible for us to pro-rate the charges for light and power to each individual department. This gives us accurately the cost of light and power which can be charged.

Should we care to carry this analysis still further and apply the cost of operating each individual motor, it would be necessary to equip the motor panel with metering devices, or better still, place the test instruments in the circuit for a certain period of time. We can then take the departmental charge and by keeping a record of the number of hours each motor is operated as well as the capacity or load on each particular motor, we can obtain estimating data which will enable us to very accurately pro-rate the departmental charge against every motor in the plant.

This system can also be used for the entire building provided that departmental meters are not a part of the regular operating equipment. When we know accurately the cost of power for each building on the different power and lighting circuits, we can pro-rate that amount without meters by estimating the total number of horsepower-hours or kilowatt-hours consumed in each department by dividing the bill in proportion to the number of horsepower or kilowatt-hours used in operating the various motors. This may be satisfactory merely for estimating purposes, but in the average plant, it would be sufficient to intelligently pro-rate the bill among departments. When we come to lighting, however, we must charge out in accordance with the capacity of lamps installed in each department provided a separate meter is not employed.

Where meters are employed for departmental charges, the total bill on each particular factory can be pro-rated in proportion to the kilowatt-hour consumption in each department. The importance of knowing the cost of power for departmental charges or factory accounts, is a check against the foreman or superintendent for operation. Meters serve as a guard against losses and not only check against the power cost but as against the cost of operation which reflects itself directly in production cost.

TAKING A CASUAL READING at the distribution center with portable testing instruments to obtain a check on the operating characteristics of the load. Here, the split transformer enables the supervising force to obtain data without interrupting the service.

QUESTIONS
Asked and Answered
By Readers

HERE IS A PLACE *where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*

Measuring Three-Phase Power

Our plant has recently been changed from two-phase to three-phase operation and a puzzling question has come up on the measurement of three-phase power. For example, on a three-phase, 550-volt feeder panel, a through-type current transformer is used on one leg of the outgoing circuit. The ammeter reading represents the current in this leg of the balanced three-phase circuit. The power factor of this circuit is 80 per cent. According to the handbooks, voltage times amperes per leg times power factor times 1.732 equals the watts in the circuit. On another panel the ammeter is cut in on the common return from the two current elements of a polyphase wattmeter. In one case, then, the current passing through the ammeter is a certain fraction of the current flowing in one phase of the three-phase circuit, wherein the other case the current flowing in the ammeter is the combined current of the two current elements of the three-phase wattmeter. I should like to know whether the formula mentioned above should be used in both cases. If so, why? B. C. A.

Auburn, Maine

* * * *

Trouble with Voltage Regulator

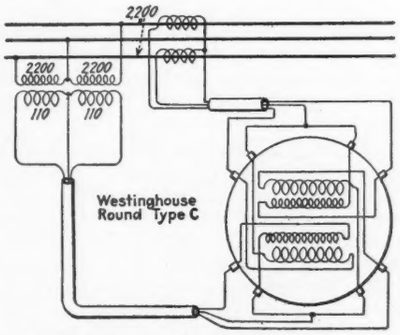
We are using a G.E. Type TA 125, Form F voltage regulator in connection with two Allis-Chalmers flat-compound, 65-kw., 125-volt excitors. After the regulator had operated satisfactorily for several years the a.c. resistance burned out some time ago and was replaced. Since then we have had trouble in keeping the voltage up. The a.c. relay contact will close, but the voltage continues to come down. Both excitors as well as the field rheostat are in good condition. Finally the regulator was removed, cleaned, all connections tightened, the pivots ground, new relay contacts, a.c. magnet core, oilpot, relay contact wires and a.c. and d.c. resistances were put in. The condensers and a.c. and d.c. magnet coils were in good order. After the regulator has been in use for about 36 hours the relay contacts become pitted, although we change the switches every six hours, and the a.c. voltage regulation becomes very poor. After we dress the relay contacts they will be good for another 36 hours of operation. I wish that some reader would tell me how to correct this trouble.

Indianapolis, Ind. J. R.

* * * *

Testing Meter Without Checking Connections

On a 2,200-volt, three-phase, three-wire delta circuit, the three wires from the potential transformers are run through one conduit and the three wires from the current transformers are run



METER CONNECTIONS as they now are on a changing power-factor load.

through another conduit to a Westinghouse type C polyphase watthour meter. It is not at all convenient to trace or ring out the wires to the metering transformers so cannot some reader advise me of another method to test for proper meter connections? Due to the changing load it is impossible to tell whether the power factor is above or below 50 per cent. E. A. M.

Cooperhill, Tenn.

* * * *

Motor Draws Excessive Current While Running Idle

We have recently installed a new machine driven by a 10-hp., three-phase, 220-volt induction motor equipped with roller bearings. Using an 8-to-1 ratio current transformer, an ammeter read 2.3 amp. Disregarding power factor and efficiency this reading would correspond to 9.38 hp., as determined by the formula, $(E \times I \times 1.73) \div 746$. With the motor running idle, the ammeter showed 2.05 amp., corresponding to 8.36 hp. The voltage was 220 at the motor terminals, the bearings are in first-class condition, and there were no grounds. Can anyone explain why this motor draws such a heavy current while running idle?

El Reno, Okla. H. T. F.

* * * *

Removing and Cooling Transformer Oil During Operation

Is it feasible to pump the oil out of a bank of three 3,000-kva., 66-kv., transformers, cool it, and return it to the transformers again while they are in operation? These transformers are of the usual water-cooled type, but the cost of city water for cooling purposes is very high. Local river water is not suitable for this purpose, but could be used to cool the oil outside of the transformers. Would there be any possible bad effect, due to aerating the oil in its passage through the pump? If this scheme is sound, I shall be grateful for suggestions as to the best arrangement of the cooling system.

Williamsport, Md. W. G. E.

* * * *

Choice of Voltage for Operating Single-Phase Motors

In a new plant that is being erected there will be a number of ¼-hp., single-phase motors for operating small drills and other tools. A question has arisen as to whether there is any choice between 110- and 220-volt motors in regard to torque, power factor, ability to maintain full speed under rated load, and so on. In other words, what advantages, if any will be obtained by using 220 volts, instead of 110 volts, for these small motors? Your comments will be appreciated.

Lowell, Mass. A. A. D.

ANSWERS *Received to Questions Asked*

Using Balancer Set to Make Three-Wire System

Would it be possible to operate a three-wire d.c. generator with a two-wire d.c. generator of the same voltage, connected to a balancer set, by using double-throw switches for throwing the load from one machine to the other? Also, if necessary, could these two generators be run in parallel with the same equipment and necessary switches for throwing each machine on or off the board? Our plan is to connect a balancer set to our present generator, which is a Crocker-Wheeler machine rated 125 kw. at 250 r.p.m., 250 volts, 500 amp. This machine is a No. 25, code No. 45780. By using a balancer set with this machine we can make a three-wire system, and then purchase a standard three-wire generator to be operated, if necessary, in parallel with it. However, before going ahead, I should like to know the experience of other readers with such a combination. I.R.
Keltys, Tex.

REFERRING to the questions by I. R. the real question is whether a standard, three-wire generator can be operated in parallel with the old generator and a balancer set, as it is obvious that either the three-wire machine, or the old two-wire machine with balancer set, can be operated singly.

Let us first consider the case of the two generators without the balancer set. Paralleling the old generator with a three-wire generator presents a problem differing in only one respect from what it would be with another two-wire generator. A three-wire generator has its series field circuit divided in two parts, one on the negative and one on the positive side of the armature, to insure proper compounding when the load is unbalanced, and accordingly requires two equalizer connections when operated in parallel with other machines.

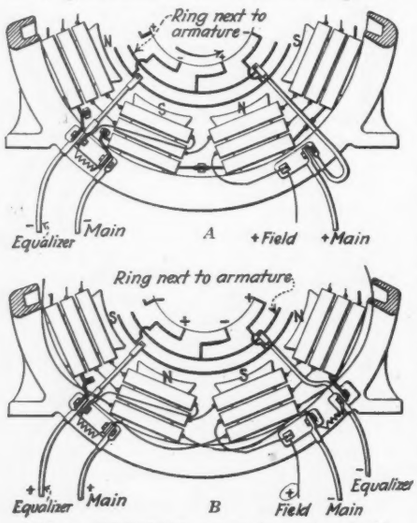


FIG. 1—PRESENT connections, *A*, of old generator, and, *B*, connections when using two equalizers.

It is thus necessary that the two-wire generator have its series field connections modified to correspond, which in this case requires that four series coils, or every other coil, be left in the present series circuit, the remaining four coils being connected in series with the opposite armature main. This requires an additional terminal block to provide for the new equalizer connection and a new series shunt, two series shunts now being required, one for each part of the series circuit. Fig. 1 *A* shows the present connections, and Fig. 1 *B* shows the connections as changed for two equalizers.

A balancer set may be operated with either the two-wire or the three-wire generator, or with both together. The only precaution to be taken when using the balancer set with the three-wire generator is to see that the unbalanced voltage regulation of the balancer is adjusted to be the same as that of the three-wire generator. A balancer set is ordinarily adjusted to hold nearly constant voltage on the two sides of the three-wire system, whereas a three-wire generator at full rated unbalance will usually show a drop of about 2 volts on the heavily-loaded side and a corresponding rise of 2 volts on the lightly-loaded side.

Under these conditions the balancer set would tend to take all the unbalanced load, instead of dividing it with the three-wire generator in proportion to their unbalance ratings. It is thus necessary to adjust the voltage regulation of the balancer set, by varying the proportion of its series shunts, until its regulation, with rated current in the neutral, is the same as that of the three-wire generator when it is carrying its rated unbalance.

An elementary diagram of the two generators and balancer set connected to the switchboard is shown in Fig. 2.

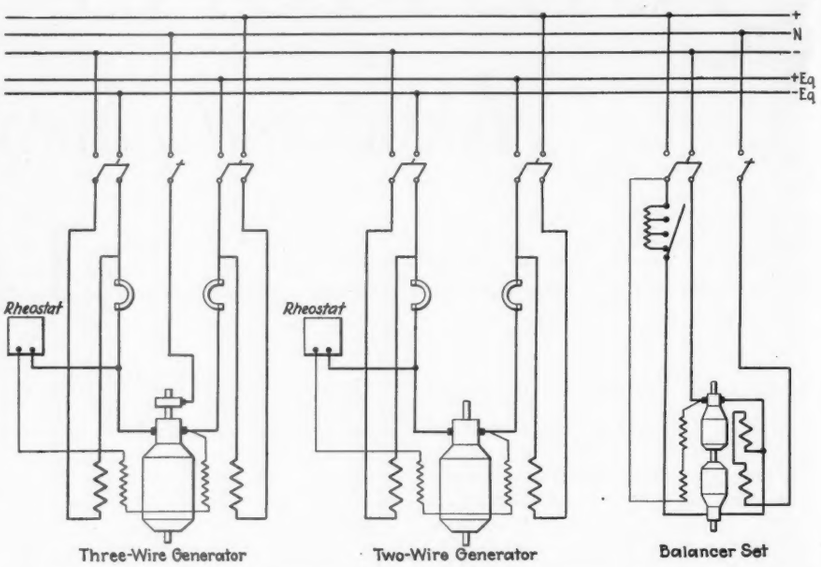


FIG. 2—ELEMENTARY connection diagram for two-wire and three-wire generators with balancer set.

Although it is perfectly practicable, as shown, to operate a two-wire generator, a balancer, and a three-wire generator together, there may be some question as to whether this is the best solution of the questioner's problem. It would seem that by merely obtaining a larger, or more than one, balancer set, he would be able to take care of whatever unbalance is expected, and could make his new generator, two wire, thus reducing the cost, and avoiding any changes on his present generator.

G. WILLIAMSON.
Direct Current Engineer,
Crocker-Wheeler Electric Manufacturing Co.,
Ampere, N. J.

How to Keep Unused Paint

What is the best method of preserving unused paint so that it may be used later on? I have experienced a great deal of trouble and lost considerable good paint through lack of knowledge on this point. A.M.
Des Moines, Iowa.

THE problem that A. M. mentions is more or less troublesome in every plant. If large quantities of paint are used, storing it in steel drums with gate faucets works out well with some materials. However, if there is a tendency for the pigment to separate and settle out to the bottom of the drum, this scheme is not so satisfactory.

On the whole, storing the paint in small kegs or pails provided with a tightly fitting cover is probably the best method of keeping it. When the paint is put away a small quantity of linseed oil should be poured over it. This will form a skin which protects the paint and can later be removed when the material is to be used.

At best there is bound to be some

ANSWERS *Received to Questions Asked*

waste, but it can be cut down to a minimum if some care is exercised. It is always desirable to purchase paint in packages that are small enough to be used up at each painting.

CHAS. A. PETERSON.

Cold Spring, Minn.

What Is Causing Trouble With This Commutator?

We are having trouble with the brushes and commutator on a 125-kw. Crocker-Wheeler direct-connected generator installed a year ago. About once a week a black spot appears on the commutator, and the mica sticks up above the bars as though something were eating the copper away. I have turned the commutator down twice, and use a commutator stone each week to cut the mica down even with the bars, but this gives only temporary relief. I have also tried using vaseline on the commutator and boiling the brushes in vaseline, as they chatter very badly at times and wear rapidly. I shall be grateful for suggestions from readers as to how this trouble may be cured. E.R.
Keltys, Tex.

IF THE copper of a commutator wears away much faster than the mica, as reported by E. R., the trouble can be remedied either by turning down the commutator, or by using harder brushes, which will cause the mica to wear away at the same rate as the copper. Both of these schemes give only temporary relief. The most permanent relief will be obtained by undercutting the mica.

The blackening of the commutator is probably a direct result of the high mica. With high mica, the brush makes very poor contact with the copper and consequently draws an arc as the commutator revolves. This burning tends to eat away the copper, and the higher the mica becomes, the faster the copper burns away.

When the commutator has been slotted or undercut, it should result in less wearing down of the commutator and of the brushes themselves. It will, however, be necessary to take greater care of the commutator, because if the slots become filled with dirt containing conducting material, there are likely to be short circuits. Slotting of commutators on d.c. machines is now the usual practice on the part of most electrical manufacturers.

Some authorities recommend that the slotting tool make a V-shaped slot, so as to give less chance for dirt to lodge in the grooves. However, unless the peripheral speed of the commutator is low or much grease and oil are present, a straight-sided slot will be satisfactory.

If a V-groove is used, care must be taken not to decrease the width of the commutator bars where the brushes rub. If a straight slot is made, be sure not to leave little side walls of mica. Also, mica is brittle and cuts should be made carefully so as not to leave the mica with cracks in the bottom of the slot.

After slotting the commutator and putting the machine back into service, the commutator should be watched carefully to see whether the brushes now in use are wearing the copper too fast. It may be found necessary either to reduce the brush tension or use softer brushes. R. F. EMERSON.

Scotia, N. Y.

REFERRING to E. R.'s question, it is possible that the low spot on the commutator is caused by the material in those segments being of slightly different material than in the others. If these segments were softer they would naturally tend to wear quicker and become lower than the others, and sparking would occur when this portion of the commutator passes under the brushes. Obviously, the high mica would tend to raise the brushes, and a burning action would result, causing the blackening of the surface of the commutator.

Inasmuch as this is a comparatively new machine, I would advise taking the matter up with the manufacturer, and if it appears that the trouble is in the commutator itself, either a new one could be furnished or new segments put in the present one. W. T. E.

Ansonia, Conn.

Why Does This Hemp-Cord Copper Cable Break?

We experience a peculiar trouble with the cable of one of our three-phase single-circuit, 60-cycle 42,000-volt transmission lines located in the tropical region where for four months of the year high winds carry salt and sand. This line consists of a single run of steel towers 600 ft. apart on which the 2/0 B&S gage, 6-strand hemp-cored copper cables are suspended in triangle position. The trouble is that the cable breaks frequently at about the middle of the span. Two or three wires in a strand usually part before the final break, which condition can easily be noted when examining the cable. Black spots show at the point of fracture and the hemp cord shows signs of being rotten and bleached out, although installation was made in 1914. In different places along the cable surface a black putty substance has been creeping out between the wires where it concentrates and forms small eruptions and gives the cable an oily appearance. This problem must be solved soon, so can someone advance a reason for the frequent breaking which occurs both in and out of the high-wind period and tell us what we can do to prevent the recurrence? B.C.
Orizaba, Mexico.

BREAKING of the hemp-core copper cable described by B. C. is typical of all hemp-core cable, especially in warm countries, and can be remedied only by replacing by solid-core cable. Otherwise the frequency of the breaks will increase rapidly until commercial service from the circuit becomes impossible. While waiting for a new cable, some relief can be had, if worth while, by slackening the tension to the limit that the ground clearances permit.

The action described is due to "corrosion-fatigue" caused by the microscopic pitting of the wire from organic acids, where it is in contact with the hemp core. The tension in the wire causes these pits to assume the shape of minute cracks across the wire which progress until the strands, and finally the whole cable, breaks. The action occurs principally at the middle of the span because rain carries the organic acids in the hemp core, resulting from the gradual decomposition of the oils used, down to the middle of the span and the higher concentration of such decomposition products offsets the slightly lower tension at mid span.

If a cable which has broken is unstranded and the individual wires bent so as to stretch the face next to the hemp core, incipient cracks of varying depth will be observed every ¼ in. or so along the entire length. They start at points where an oxide inclusion shows at the surface. As a certain proportion of oxygen in the copper is essential for the proper drawing of the wire, the quality of the wire cannot well be blamed, although investigation would doubtless show some wires to have higher corrosion-fatigue strengths than others. The remedy, however, is to avoid the hemp-core altogether.

If wire drawing and stranding machinery is available, much of the wire can be annealed carefully and drawn down a few passes to 0.56 of its diameter and restranded to make a 19-wire cable (such as is often used in European practice) which will last indefinitely, but is more subject to mechanical injury because of the smaller wires.

Where the cracks penetrate too deep the wire will break, so that some selection is necessary to avoid too much delay in redrawing; cracks that are not so deep disappear in the drawing action, due to the flow of the metal.

This procedure resulted in a large saving in Rio de Janeiro some years ago, enough new, solid-core, seven-strand cable being purchased to replace the scrapped portion.

If wire drawing machinery is not available, or its considerable cost is not justified, the hemp-core conductor must be scrapped completely.

This trouble occurs principally in warm countries, but has been noted as far north as Michigan. On the plateau near Mexico City, the action has been observed, but is so slow that no trouble has yet been caused.

While this explanation has not previously been published, careful investigation of several cases and experience in redrawing the conductor shows that it is exact. The recent publications of Mr. D. J. McAdams (Annapolis Experiment Station) are of great interest in this connection, as his researches on other metals illustrate precisely what happens with hemp-core cable.

A. W. K. BILLINGS.

The Sao Paulo Tramway, Light and Power Company, Ltd.,
Sao Paulo, Brazil.

ANSWERS *Received to Questions Asked*

What Changes are Required With This Generator?

Will some reader suggest the best and most economical method of adapting a d.c. 15-kw., 125-volt, 120-amp., 1,500-r.p.m. G.E. generator for welding purposes? We have this generator which is driven by an a.c. motor on hand and would like to use it in this manner.
Wappingers Falls, N. Y. W.F.S.

IN your issue of January 29th, under the heading "Questions Asked and Answered," W. F. S. of Wappingers Falls, N. Y., asks how he can change 15-kw., 125-volt, 120-amp. generators into welders.

The answer to the question by W. F. S. is that if he wants to get a welder of proper characteristics and capacity it is impossible to do it. The reason for this is, first, that any welder for the usual work should have a capacity of at least 200 amp.—300 amp. would be preferable. It is self-evident, therefore, that the commutator of this machine, which is built for 120 amp. would not be of sufficient capacity to carry two or three times this amount.

Second, the open-circuit voltage of the welder would be but little more than half the open-circuit voltage of his present machine. Probably the number of slots and number of commutator bars is such that the lower current winding could not possibly be put into the machine and get a properly connected armature.

In the third place if these difficulties were overcome in some way he would still have, after he got the machine built, an equipment which would not be at all satisfactory for modern welding. He would then have merely a 65-volt, 240-amp., 15-kw. generator with which it would be necessary for him to use resistances so as to absorb the voltage between 65 or 70 and the voltage of the arc, which is approximately 18. In this way he would throw away at least two-thirds of the power in this resistance; at the same time he would not get an arc characteristic which is anything near as good as one given by a modern machine.

The proper characteristic for a welding arc is given by a machine which has a drooping characteristic, in which the current decreases as the voltage increases at an adjustable ratio, and one in which the amount of current flowing in the arc at 18 volts can be adjusted from approximately 50 to 300 amp.

This type of machine cannot be built successfully from the generator mentioned because of the difficulties noted above, and also because the magnetic circuit would not give the response to the very rapid change in flux in the magnetic circuit that is necessary to properly maintain the arc.

It is always inviting to the manufacturer to use every device possible to reduce his equipment cost, and it is altogether natural that he should attempt to do this same thing in the manufacture of welding equipment. However, this same man would undoubtedly not consider trying to build a modern lathe from the wreck of a lathe of twenty years ago which was built for carbon tool bits, in spite of the fact that perhaps a lathe of this kind could be built which could limp along and actually do some classes of lathe work.

Modern manufacturing requires the best possible tools and in this country the limiting of proper tooling to saving in first cost is very poor economy.

Vice-President, J. F. LINCOLN.
The Lincoln Electric Company,
Cleveland, O.

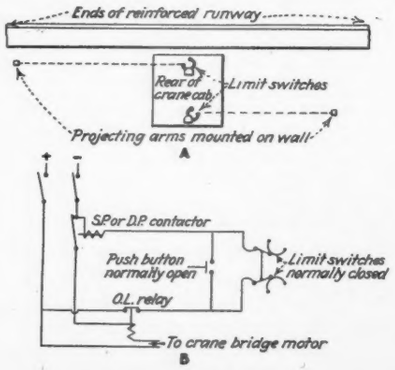
What Is the Best Method of Stopping This Crane?

I shall appreciate it if readers will help me solve the following problem. We are putting up a new crane runway, on which there will be three electric traveling cranes, two of which will be of 10-ton capacity, and one of 50-ton capacity.

The 50-ton crane is to operate only on certain sections of the runway, which will be reinforced. We do not want this crane to go on the part of the runway that is not reinforced, but the runway must be free of bumpers at each end of the reinforced section, so that the 10-ton cranes can work in this section.

Stopping of the 50-ton crane at the ends of the reinforced section must be effected electrically and automatically, and so arranged that by resetting the relay or some other device the crane can be moved back into its own section. How can this best be accomplished?
Vandergrift, Pa. G.J.K.

WITH reference to G. J. K.'s question, I suggest that on the back of the crane cab or some convenient place, he mount two limit switches similar to the Type E limit switch made by the Electric Controller and Manufacturing Company. The limit switches should be mounted on a small, strap-iron support and should be placed one above the other. At or near each end of the reinforced crane runway should be placed a fixed arm so as to trip the limit switch when the crane passes. This arm should project only far enough to trip its corresponding limit switch, but not far enough to interfere with either of the 10-ton cranes, and may be mounted either on the wall or the bottom of the runway. As the two arms are not in the same plane of travel they will trip only the corresponding limit switches.



ARRANGEMENT of limit switches, *A*, and method of connecting them, *B*, into the control circuit of the crane bridge motor.

The two limit switches should then be connected in series and also in series with the coils of the main line contactor, or of the contactor which feeds the crane travel motor. Most cranes have a double-pole main line contactor, or one could be purchased if necessary. A push button should then be connected so as to shunt out the two limit switches in case of overtravel, but it should be of the type that is normally open and would have to be held in the closed position by the operator while he was backing up through the limit switch. The reason for a push button which is normally open is to prevent the operator from leaving it in the closed position and thus defeating the purpose of the limit switch.

The illustration shows the diagram of connections and the location of the switches.

Chief Electrician, F. H. ROONEY.
Columbia Steel Corporation,
Provo, Utah.

Soldering Nichrome for Low-Resistance Joints

Will some reader tell me how to solder nichrome resistance wire, and how a joint or splice can be made whose resistance will be as low or lower than the rest of the coil or element?
Union, S. C. C.D.F.

FOR welding nichrome resistance wire, C. D. F. can use a compound known as Fuselle, which is manufactured by the Airlox Rubber Company, 6803 No. Clark St., Chicago, Illinois.

If the instructions are carefully followed and a good weld is made, I have found that the resistance of the splice will be lower than that of the rest of the element. A. N. Voss.
Inspiration, Ariz.

ANSWERING C. D. F., I have used a preparation called Carricite to solder nichrome resistance wire. This compound is manufactured by the Carricite Company, 5200 West Harrison St., Chicago, Illinois.

To make a joint, twist the ends of the resistance wires together as for an ordinary soldered joint and apply enough current to heat the wire to a dull red. The joint will, of course, be much hotter. Then apply a small quantity of Carricite, which is in powder form, and work it into the joint until the ends are firmly united.

Chief Electrician, PHILIP N. EMIGH.
Byrne Gas Coal Company,
Fairmont, W. Va.

Layer-Wound Pulled Coils

for partly-closed-slot machines

By A. C. ROE

Renewal Parts Engineering Dept., Westinghouse Electric & Manufacturing Company East Pittsburgh, Pa.

Simplicity of construction and ease with which they can be insulated and installed are highly desirable features for coils used in motor windings. The author describes, in the accompanying article, a form of layer-wound, pulled coil that possesses these qualities in unusual degree and is particularly well adapted for use in machines having partly-closed slots.

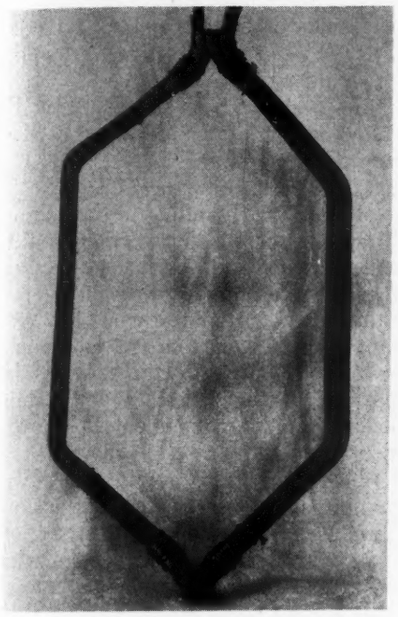


FIG. 1—TYPE CCL Puller coil showing method of insulating and tying ends.

THE coil described in this article is one of the simplest coils to wind and insulate and was developed for the Westinghouse Types CCL and HF motor stator coils. It was also used in the rotors of Types HF and F motors.

The smaller motors of the above types used the basket winding with the untreated coil, but this type of winding was not suitable for larger machines and as partly-closed slots were desired at that time, a coil that could be wound in layers and threaded in was considered to be the ideal. This meant a shuttle puller coil giving a two-layer, diamond-shaped-coil type of winding, as this type of coil is simple to manufacture and easy to install.

At the same time, the problem of treating the wound stator was considered. This study eventually lead to the idea of treating the wire before making the coils, which meant that coils could be made from treated wire, the stator wound, given a finishing coat of varnish and then shipped.

This wire was called gum-treated wire, being treated with a gum that remained plastic and allowed the coils to be wound and pulled without cracking or injuring the gum-filled cotton covering.

This process proved to be so satisfactory that it is still being used in later designs of machines.

We will call this coil the CCL Puller, the operations being as follows: (1) Make the shuttle. (2) Wind, taping the starting lead with one layer of .0045 x ¾-in. cotton tape, half-lapped for 110,220, and 440 volts. (3) Pull and firmly tie the coil.

The front diamond point is taped with one layer of .007 x ¾-in. cotton tape extending about 1-in. on each side of the diamond point. Four cord bands of ten-cord waxed machine thread are placed as shown in Fig. 1.

For 550-volt coils the starting and finishing leads are taped with an edge-lapped layer of .0045 x ¾-in. cotton tape.

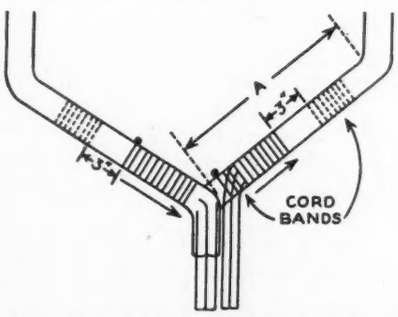


FIG. 2—WHEN DIMENSION *A* equals 8 in. or more, another set of eight-cord bands is used on the coil. These bands are placed 3 in. from the bands at the diamond points.

* * * *

The rear diamond is not taped, the cord bands being applied to hold the coil in its given shape while winding the stator.

The reason for taping the front diamond point is to protect the diamond point where the starting lead passes it, and also provide protection to the lead end of the coil when soldering the stub and lead connections, etc., during the connecting of the stator.

When dimension *A* in Fig. 2 is 8 in. or more, additional eight-cord bands are used, placed, as indicated by the dotted lines in Fig. 2, 3 in. from the end of the bands at the diamond points.

Fig. 3, which represents a side elevation view of the coil in Fig. 2, shows the taping dimensions for the leads and tape around the front diamond point; the tape should extend 4 in. along the lead and project at least ½ in. beyond the end of the coil.

The tape around the front diamond point should start and end from ¾ in. to not more than 1½ in. from the bend.

The ¾-in. length should be used for coils having short ends, i. e., dimension *A* Fig. 2, and the 1-in. or 1½-in. length for long coil ends.

If the tape or cord bands are extended too far along the coil ends, they will interfere with the spreading of the turns, when threading the coils into the stator.

Fig. 4, *A*, *B*, *C* and *D*, show the method of starting and finishing the cord bands. The cord used is ten-strand and is wax-treated, making it tacky and moistureproof. The cords are first cut in 36-in. lengths and

hung on a nail or the center axis rod of the puller by folding in half; then the half-loop end is placed on top of the coil with the looped end away from the operator. The free ends are brought around under the coil and through the open loop; this loop should be held open with the thumb and first finger of the left hand, which project through it, so that the free ends may be gripped between the thumb and finger and pulled up through the loop.

The loop is next pulled up tight; at the same time square up the wires in the coil and keep the cord free from crosses, as shown in diagram *B* Fig 4. Next, make three full turns of the double cord; then place a loop of string on top of coil with the loop to the right, as shown in diagram *C*, Fig. 4.

Take two turns of the cord over this loop and then pass the free or running ends of the tie cord through

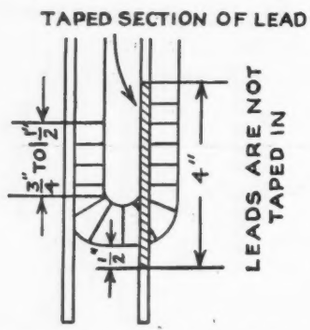


FIG. 3—TAPING dimensions of the coil shown in Fig. 2. The tape should extend 4 in. along the lead, and ½ in. beyond the end of the coil.

* * * *

the loop, as shown in diagram *C*. Pull the loop and free ends through, *D*, and under the last two turns and cut off the free ends; this procedure locks the cord.

A total of six turns of a doubled cord is sufficient, as this makes a cord band of twelve strands. The cord bands should be applied tightly and kept together and free from

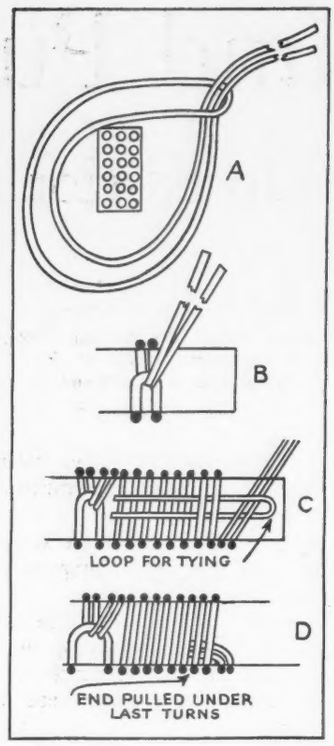


FIG. 4—METHOD of starting and finishing the cord bands on CCL Puller coils. Diagrams *A* and *B* show how the loop is started. In *C* the loop for tying has been inserted, and in *D* the loop has been pulled tight, locking the cord.

* * * *

crosses. All cord bands should be kept close to the diamond points, see Fig. 1, and uniform.

A left-hand coil is easier to tie than a right-hand coil, as the operator can stand facing the coil and work from left to right with less interference from the leads.

For the CCL Puller type of coils we will have to add a symbol to indicate stator and rotor coils; thus let CCL-SP represent stator coils and CCL-RP represent rotor coils.

All CCL-SP coils are pulled with the leads on top and the long cell on the bottom.

Fig. 5 shows a CCL-SP (stator) coil at the left and the CCL-RP (rotor) coil at the right; note the method of bringing out the connecting leads.

The reason that rotor coil leads are brought out on the bottom is that all connections are made on the inner circle, which eliminates the bending of the coil leads down across the coils, whereas stators are connected with the cable leads and jumpers lying on top of the coils or end windings; hence leads are placed on top.

The coils shown in Fig. 5 are both left-hand coils.

Fig. 6 shows a left-hand CCL-SP coil, and Fig. 7 a right-hand CCL-SP coil.

Fig. 8 shows how the CCL-SP coil is prepared for winding in the stator. First, the bottom slot section of the coil is divided into as many parts as there are wires wide and these sections spread up and down. For example, in Fig. 8 the coil is wound with four turns of three wires in parallel, arranged three wide by four deep. This arrangement is shown diagramatically in Fig. 9.

Then section *3* is pressed down until the top wire is below the bottom wire of section *2*; also, section *1* is pushed up until its bottom wire is above the top wire of section *2*; this arrangement is shown in Fig. 10 on page 209.

It is done by holding the coil in both hands, with the thumbs at each end of the slot section and pressing on top of the inner section, *3*, and the first fingers of each hand on the bottom of the outer section, *1*; then with a push-and-pull motion the coil will spread as shown.

If the wires stick it may be necessary to split the sections by running a piece of 1/32-in fiber between sections *1* and *2*, and also between *2* and *3*. Next, pick up the layer of the top half of the coil, as shown to the right in Fig. 10.

The above spreading allows the coils to be quickly placed in the slots;

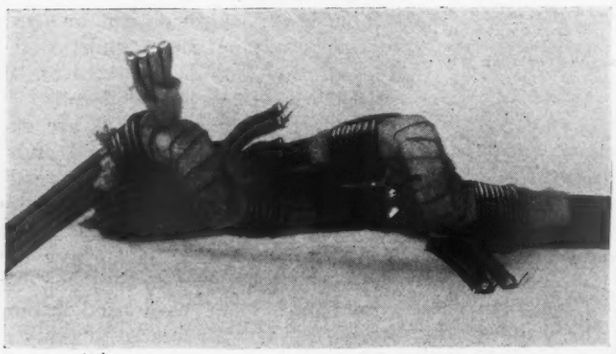


FIG. 5—THE COIL at the left is a left-hand CCL stator coil with the leads on top.

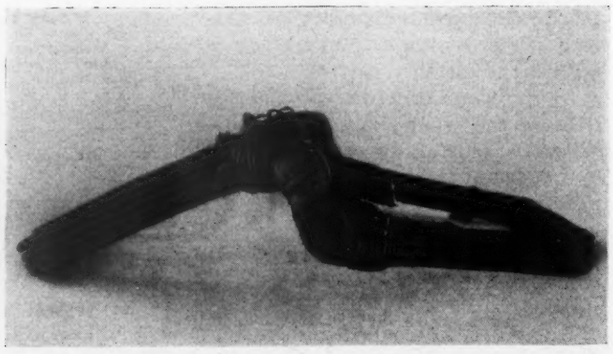


FIG. 6—THIS is a left-hand CCL stator coil. All CCL coils are pulled with the leads on top.

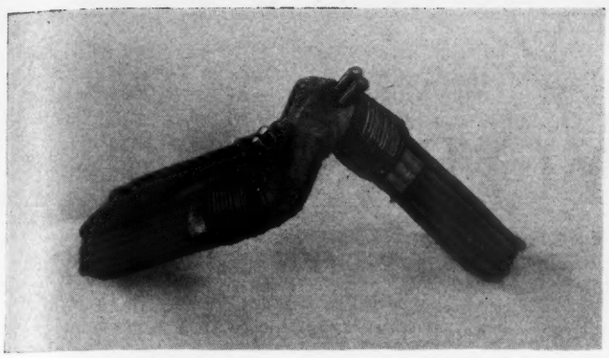


FIG. 7—**A RIGHT-HAND CCL stator coil. Note the method of bringing out the connecting leads.**

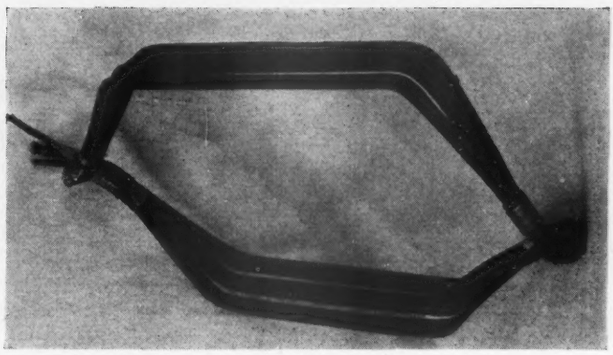


FIG. 8—WHEN READY to be placed in the stator the wires of the coil are separated into as many sections as there are wires wide.

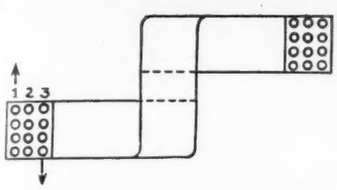


FIG. 9—ARRANGEMENT of conductors in the coil shown in Fig. 8, which is wound with four turns of three wires in parallel.

* * * *

a push of the thumbs puts the three bottom sections together again when the coil is in the slot.

The CCL Puller type of coil is a good one to use for partly-closed slots, when the wire is No. 13 or larger and the machine of 20 hp. or more.

Taping of the coil ends for phase coils, or if all coils are taped, must be done while winding the stator, as spreading the coils requires a long lift to avoid the appearance of sharp bends or kinks.

That is what would happen if the cord bands were allowed to extend too far along the ends, or if the tape is applied too near the ends and brought too close to the slot sections.

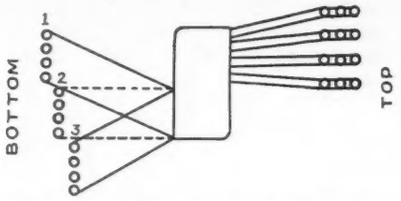


FIG. 10—BEFORE inserting the coil in the slot the different sections, *1, 2, 3*, are separated as indicated here.

* * * *

The CCL Puller coils follow the rules given for puller coils in the April, 1928, issue.

How We Are Organized for Maintenance *and* Plant Housekeeping

(Continued from Page 181)

are not in use. Leaky lines or connections also play an important part in causing waste. Individually such misuses or leaks may appear to be small and perhaps pass unnoticed, but in the aggregate they make a surprisingly large total—a total that can be reckoned in hundreds or even thousands of dollars a year.

A large part of our production equipment has been designed and built here; hence, we are continually making studies of our production processes and improving the designs of the special equipment that is now used.

It is largely for this reason that maintenance and development of such equipment are closely tied together. Among the advantages of this arrangement is the fact that experience in handling maintenance gives valuable information regarding the parts that give the most trouble through undue wear or failure, thus indicating weaknesses in the design of the equipment.

With all of our equipment, in fact, we consider that failure or trouble is much more than something to be detected and repairs made as soon as possible. Repairs must be made quickly, of course, but it is just as important, perhaps more so, to determine and if possible remove the cause of the trouble. It may be due to defective design, poor or improper materials, unduly severe operating conditions or any one of a number of causes. Whatever the reason may be, it should be determined, and effective steps taken to correct it. Only in this way is it possible to keep maintenance costs down and increase the efficiency and reliability of operation.

These policies have been worked out in a practical form by placing an engineer who is responsible for maintenance and development work in each one of the six important production departments. Repairs and maintenance work are handled in accordance with the routine outlined herein. The feature of most importance, however, is that these engineers are constantly improving the design of our equipment on the basis of the information gained in their close study of the processes and the experience derived from intimate contact with the operation and maintenance of the machines.

The chief engineer is kept in close touch with all of this work by means of a weekly progress report which is submitted by each maintenance and development engineer, and states briefly what he has done on current jobs, with a description of all projects that are to be undertaken at the first opportunity.

Perhaps the best indication of the success of our methods of handling maintenance work are to be found in the reports which show that maintenance costs and failures of equipment have steadily been decreasing for several years, whereas production figures have been mounting just as steadily.

AROUND THE WORKS

THIS SECTION *is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.*

* * * *

Surge Ring Failure Due to Starting Current Inrush

SOME time ago we were asked to investigate a motor that was giving trouble. It was a 100-hp. 550-volt three-phase, 25-cycle, 750-r.p.m. squirrel-cage type, and was belted to a heavy exhauster fan in a large textile mill.

When the compensator was thrown to the starting position the motor would come up to speed, but when thrown on full-line voltage a bad flash appeared, apparently at the end rings of the rotor. The rotor was carefully examined, a V-groove was machined in each ring, and all the bars thus exposed were welded with an acetylene torch. This process eliminated the possibility of any loose or broken bars. The flash, although severe, lasted only a small fraction of a second, and the motor continued to run satisfactorily; inasmuch as there were no marks or burns, it was difficult to find the exact location. A flash in this particular part of the mill was a very dangerous fire hazard, due to the large amount of fine and inflammable lint held in suspension in the air.

At length, by accident, a hot spot was found on the surge ring to which the coils were tied. A careful examination revealed two places where the insulation on the surge ring was burned through to the iron; also, the insulation was burned on the coils at these places. These two coils were located in different phases.

It became clear after further study that the coil stresses resulting from the starting current inrush were not sufficient to make these coils bend enough to strike the surge ring. They would strike the surge ring, however, when the starter was thrown from the start to the running position and, of course, as the surge disappeared the coils contracted to their natural position and the motor continued to run.

After repairing the damaged coils and tightly lashing all of them to the surge ring, an Allen-Bradley primary-resistance starter was installed. In this type of starter a very low voltage is first applied to the motor terminals, and the voltage is gradually raised by increasing the pressure on the graphite disks. The resistor is then short-circuited and the motor connected to full line voltage without at any time opening the starting circuit. No further trouble was experienced.

On such applications as fuller mills in cement plants, exhaust fans, and so on, or where the synchronous speed of the motor is high, it is not only necessary to have the coils tight in the slots, but the coil ends must be firmly lashed to the surge ring; this is particularly necessary where the auto-transformer type of starter is used.

R. K. HOKE.
Manager,
Keystone Electric Company,
Baltimore, Md.

Installed Conduit Re-Shaped in Place for New Construction

DURING the course of reconstruction in a mid-western industrial plant, it became necessary to lower three 3-in. ducts containing three 350,000 circ.-mil cables 15 in. for a distance of 97 ft. To dismantle this line would have been a good sized job, so ways and means were studied to lower this as a unit. At one end of this run there was a 7-in. offset; at the other end, the conduit rested on a 15-in. beam at the high level. The problem was to get these ducts below the 15-in. beams and to do so without dismantling the conduit or damaging it when lowering it intact.

We finally agreed to turn the offset, wire and all on one end in order to get down 15-in. lower, also to put the offset at the other end of the run while the wires were left in the conduits. To do this, the conduit was shored with a 10x10-in. timber at the right height and braced to prevent slipping back. The conduit was then anchored to a blower foundation with a 1-ton chain block to prevent raising. Another 1-ton block was anchored at the point where we wanted to bend the conduit down to the lower level.

This worked out nicely as the 15-in. offset was put in as well as could have been done with an empty pipe. To prevent breaking or shearing at the couplings, we put 1x6-in. plates, 3 ft. long with ⅝-in. U bolts at each end. These may not have been necessary, but, inasmuch as the pipe did not break, they must have done some good. The accompanying sketch shows the scheme which was employed.

To cut these conduits and lines and re-route these ducts below the beams would have required 180 or 200 man-hr. plus quite a bit of material, but as it worked out, it only required the material shown, and it was done in 34 man-hr. The beams under which the ducts were to be placed had not yet been installed, but levels had been taken and the ducts moved before they were installed. For the sake of safety, the power was off while this work was being done.

J. E. BENEZE.
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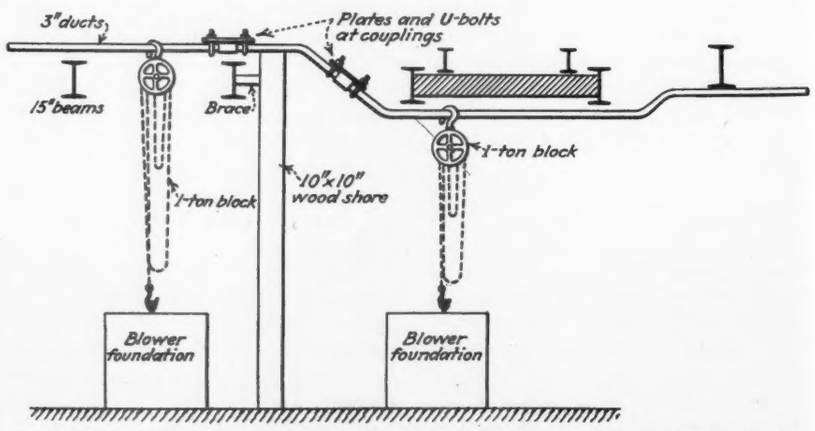


CONDUIT DUCTS lowered intact to permit the installation of additional steel frames at former conduit level.

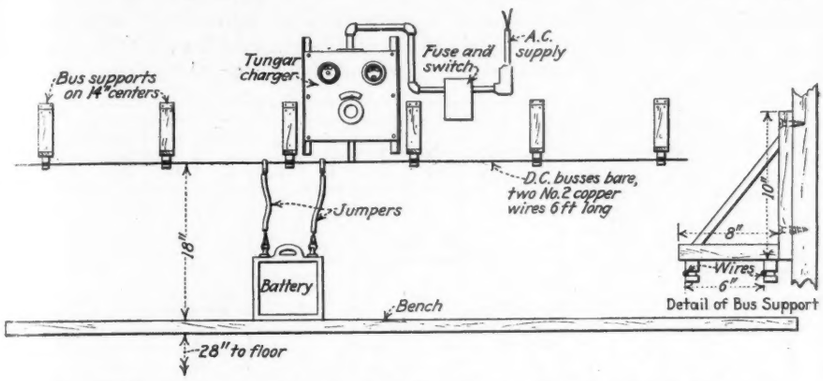
Battery Charging Room for Plant Trucks

THE writer was formerly employed by a company that operated a fleet of about 30 automobiles, trucks and tractors, the storage batteries of which often required frequent charging. Inasmuch as direct current was not available, it was necessary to install a charging outfit and the scheme shown in the illustration was adopted and proved to be very satisfactory.

A small room about 8 ft. square was set aside as a charging room. This room was lined with plaster board and a small ventilator installed in the roof. A bench 18 in. wide was placed along one wall; this bench was constructed of 2-in. plank and supported strongly enough to bear the weight of several heavy batteries on charge. A full-wave rectifier was then installed about the center of the bench and well up out of the way.

A number of short jumpers, consisting of heavy, insulated conductors, were made up with clips on each end for connecting the batteries to the d.c. busbars. This arrangement was adopted so that batteries could readily be connected up at any particular location on the bench without having wires lying all around the place. As will be seen, the batteries are charged in parallel across the d.c. busbars.

Cold Spring, Minn. CHAS. A. PETERSON.



LAYOUT of charging bench for automobile and truck batteries. The batteries are connected to the d.c. busses by short lengths of heavy conductor equipped with clips at the ends.

Improvised Grinder for Turning Hard Steel Rollers

RECENTLY we had some steel rollers, used in one of our concrete mixers, that needed turning down in a lathe. However, the rollers were highly tempered, and so hard that the lathe cutting tools would not touch them.

As the job had to be done quickly, and there was no time to order any special equipment, a ½-hp. motor was coupled to a 8-in. emery wheel mounted on a heavy polishing head, and the whole outfit mounted on the tool carriage of the lathe, replacing the regular cutting tools.

With this improvised grinder a very satisfactory job was done in a short time.

Chief Electrician, JOSEPH M. SPITZER.
Turner Construction Company,
Maspeth, L. I.

A Simple Tool Recording System

THE disappearance of small tools has always been a problem in shops where they are in daily use. In the larger establishments this loss has been partly overcome by the use of elaborate and oftentimes expensive systems of checking and storing. For the smaller plants this plan would obviously be impractical and uneconomical. It was for a plant of the latter type that the following system was devised.

Each individual is provided with a separate tool box containing the tools of his trade in most common use. The box itself is constructed of wood and solidly made with lock and handle. It is about 18 inches long by 8 inches square. A list of the tools in it is pasted on the lid, a duplicate of this being signed for by the man on securing the box from the storekeeper, with the statement to the effect that he has checked the contents of the box and that the complete equipment is in his charge, and that any losses will be deducted from his pay on turning the box back to the storeroom.

The replacement of broken or worn out tools can be made only by producing the broken parts, and in the case of lost tools, only when accompanied by an order from the head of his department, who accepts the responsibility of ordering the new tool. In the case of large tools and special tools, such as electric drills, dies, gages, etc., a brass tools check is required from the one withdrawing the equipment. This check, upon which is the man's number or name, is then placed next to the spot which was occupied by the tool. These tools can be stored on a board painted black with the outline of the tools in white, so that its absence can be noted immediately and its whereabouts traced by means of the check. Tools that he cannot account for are stopped from his pay. The habit of allowing him to get a note from his foreman clearing him of missing tools is not to be encouraged as it tends to kill the effect of any system, however efficient.

Without some such system as has been outlined it is almost impossible to keep track of small wrenches and other handy tools that have a peculiar habit of disappearing without leaving a trace. Of course, in a machine shop or similar organization, mechanics have their own small tools, but in a mill or large plant the average operator or mill man is not expected to carry his own equipment and this is usually supplied by the management. For handling a small quantity of tools, a handy revolving shelf for the storekeeper can be made by fitting a piece of 2-in. pipe in a socket attached to the floor or anchored in the ground. One shelf can be made from light-gage iron and welded to the pipe about 5 ft. from the ground. This shelf should be made of octagonal shape with a narrow angle iron wall around, and between sections. Another shelf about 12 or 18 in. lower and slightly larger can be welded to the pipe.

Arcadia, Calif. M. C. COCKSHOTT.

Shifting Brushes Corrected Instability of D. C. Motor

A COMPOUND-WOUND, 200-hp. d.c. motor was recently installed in a steel mill to drive a large circular rail saw. When this motor was started it was found that the speed variation was about 30 r.p.m The field was checked to see that the series field was cumulative by running the motor first as a series motor and then as a shunt motor; rotation was the same under both conditions.

It was noticed by sighting along the brush-holders with respect to the center of the main pole that the brushes had slipped off neutral, being moved in the direction of rotation a little more than one bar. They were moved back to the neutral position, which in this case was indicated by a dowel, and the motor immediately settled down and ran uniformly, even at high speed.

Due to the brushes being in advance of neutral, the interpoles were acting as a differential series field, thereby weakening the main field flux with the result that the motor had a tendency to race.

When the commutating coils are directly under the interpoles (the brushes being on neutral) they have no influence on the speed. If the brushes were back of rotation, the motor would have been stable, but the regulation would have been poor, since under this condition the interpoles would aid the main poles. E. J. SACCO.

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Westinghouse Electric and Manufacturing Company,
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Housekeeping Tools and Methods

for the plant lighting system

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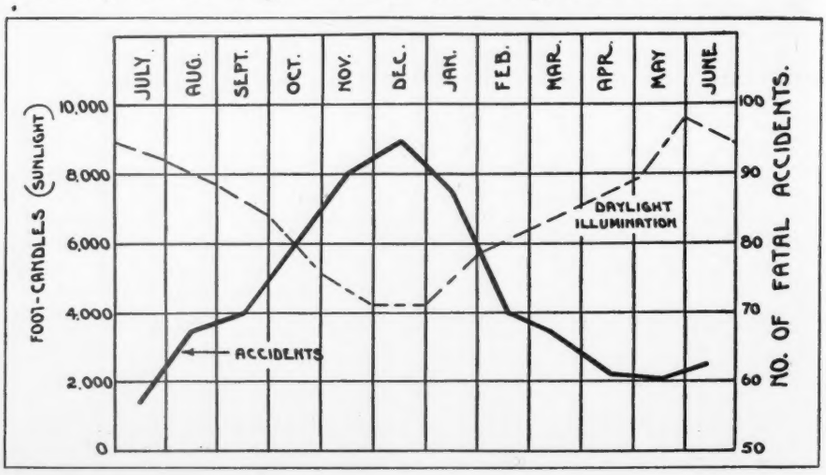
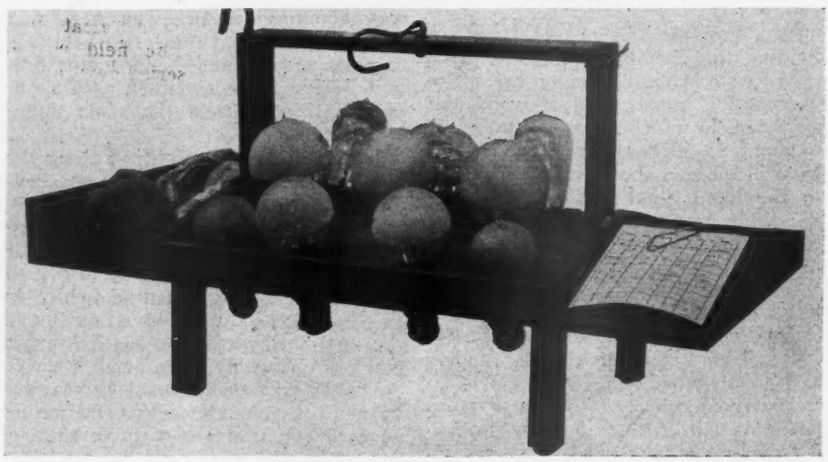
NO progressive plant engineer allows his machines to run continuously without a periodic cleaning. He is aware of the fact that unless a machine is cleaned at definite intervals, it loses is accuracy, ages prematurely, and becomes inefficient. Practically every industrial plant, therefore, has a definite periodic cleaning and oiling program connected with the manufacturing schedule. Usually, the last hour before closing on Saturday is the time allotted to the plant during which time each workman closes down his machine, and with a piece of clean waste he proceeds to remove all dirt and grit from the working parts. Often a special workman is delegated to clean and inspect the apparatus. Through this procedure, the plant engineer knows that he is getting the most useful work out of his machinery for the power it consumes.

An efficient lighting system in a plant generally consists of gas-filled, white bowl Mazda lamps in porcelain-enameled, steel dome reflectors spaced from 10 to 15 ft. apart and and from 8 to 12 ft. above the floor. In a great many cases these receive no more attention after they are installed, yet a new machine added to the shop is immediately placed under the weekly cleaning schedule in order to preserve its accuracy, efficiency and life. Since artificial illumination is absolutely necessary on dark, cloudy days, late afternoon, or at night, the lighting system is really a part of the shop machinery, and should, therefore, be subjected to a cleaning schedule (like that for shop machines) in order to get the most useful light out of the equipment for the power it consumes.



SEASONAL variations of fatal accidents. More accidents occur when daylight is inadequate, that is, in the months during which the plant lighting systems are used most.

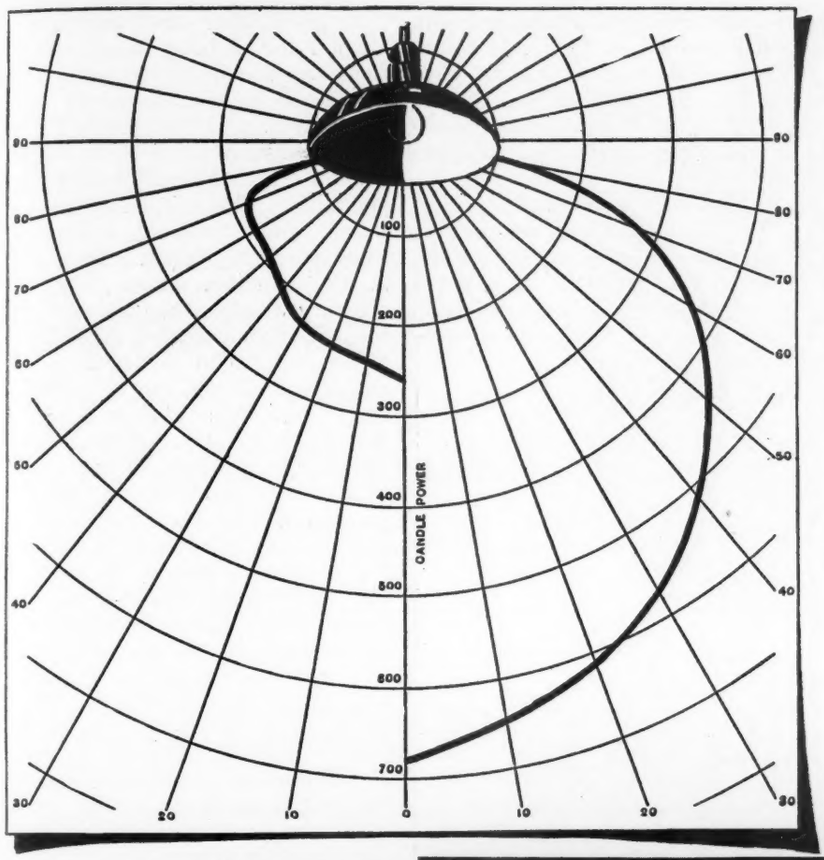


PORTABLE lamp carrying and cleaning rack for the maintenance man responsible for the lighting equipment. An idea of its size may be had by comparing it with the pencil on the shelf.

Cleaning Reflector Equipment

Dust and dirt allowed to accumulate on the reflecting surfaces of lighting equipment, one month after its installation, may decrease the light output from 15 to 25 per cent. The absorption of otherwise useful light by dust or dirt that collects on reflectors as well as on wall surfaces, is in a great many cases the cause of a good, newly-installed system rendering insufficient illumination for the kind of work performed. In the average shop where dust is set in motion merely by persons walking about or by an occasional draft, the reflectors as well as the lamp bulbs should be wiped off every two weeks, with a dry, clean cloth.

At a period of every four or five weeks, the equipment should be washed with warm water to which a little household ammonia has been added, that is, one cupful to a pail. A sponge or a soft brush will serve well for washing the reflectors, and a clean cloth for drying. Do not use dirty waste or a greasy rag for wiping as this will leave a thin film of grease on the surface to which dust will readily adhere. In locations where dust is prominent, due to a particular manufacturing process, or where grease frequently lodges on the reflectors, the equipment should be wiped off at least once a week and washed every third or fourth week. In the latter case, the use of plenty of water and a soft soap such as auto



COMPARISON of candle-power curves for a reflector before and after cleaning. The light lost or energy wasted before cleaning was 66.4 per cent by actual test. At your energy rate and four hours use per working day, what does this mean to you per year?

soap, is a good method for removing a crusty dust or greasy layer from the reflecting surfaces.

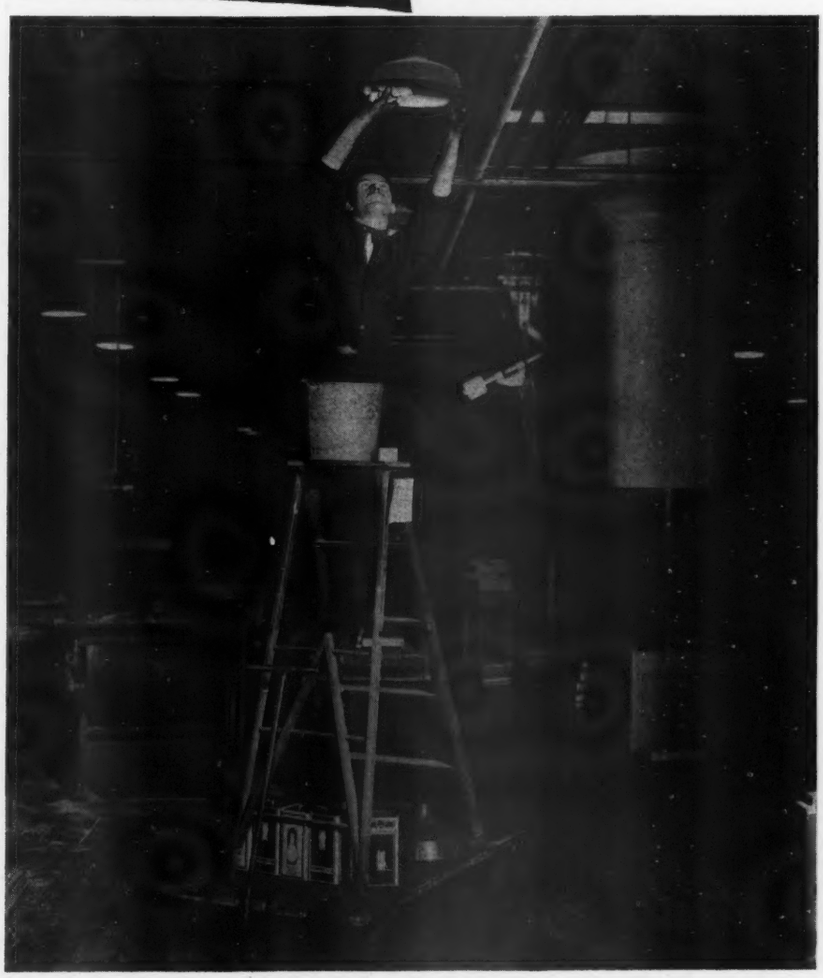
Cleaning Wall Surfaces

Since the walls and ceiling receive a great amount of the light from the reflectors, it is important that these surfaces be finished in a light, flat color so that the illumination received is diffused and re-reflected where it will reach the working areas in the shop. Dark colors such as deep greens, reds, or oak shades absorb a large percentage of this incident light. Unfortunately, in places where such a condition is discovered, a year or so after the new installation has been made, the cause for this depreciation has often been laid to faulty design of the lighting system.

To get the most useful light from a system, the surfaces above eye level should be covered with a good, flat white paint. Avoid the use of high glosses or enamels as they produce glare and eye strain. However, over a period of from six to twelve months, these white painted wall surfaces take on a coat of dust, smudge or grease in a very gradual manner, so that ordinarily this layer will escape notice of a person daily occupied in the shop. As a result, this coat of dust and dirt becomes a heavy absorber of useful light, and the reflecting characteristic of the white paint is materially reduced.

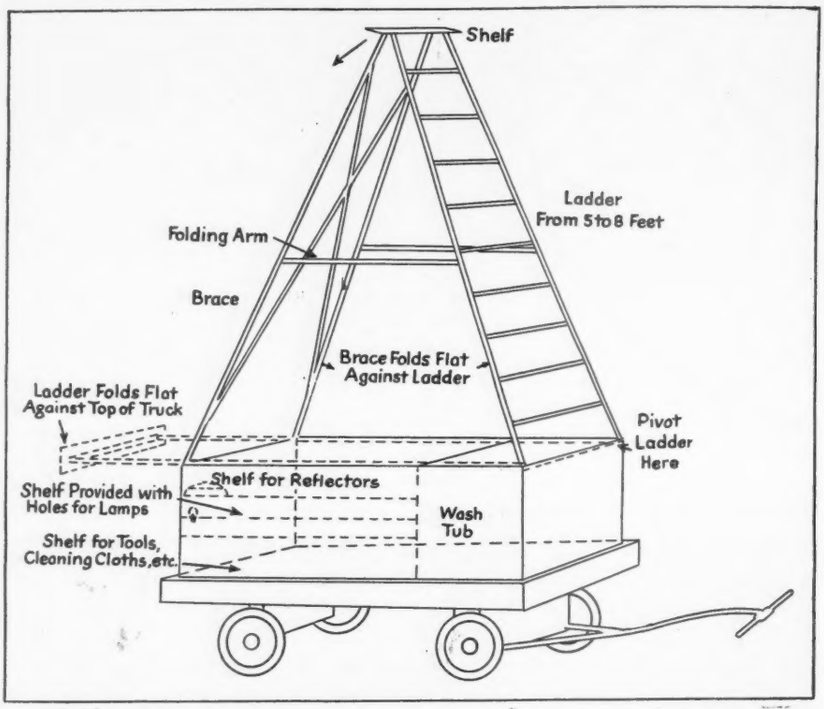
To renew the painted surfaces, the walls should be washed with a sponge, using plenty of cold water and a soft soap. Starting at the top and working downward, washing the surfaces evenly and thoroughly to avoid streaking. A reputable paint manufacturing concern recommends the following method of preserving and retaining the illumination and wearing qualities of factory flat white paint.

After the coat of paint has thoroughly dried, cover the surface with ordinary laundry starch dissolved in water. The starch solution can be easily applied with a calcamine brush, starting at the top and working downward, exercising care to distribute the coat evenly. When



A SIMPLE time-saving method of cleaning lighting equipment in large shops or factories. A record sheet attached to the ladder enables maintenance man to keep accurate data on lamp renewals, performance or breakage.

dry, there remains a thin, transparent, protective coat over the painted surface. After a period of ten or twelve months, the dust and dirt that has collected on the wall surfaces can be readily removed by using plenty of water and a large sponge on the starch coating (on which the smudge and dirt has settled) to dissolve it. When all the starch coating is entirely removed, there will remain the clean, white, unmarred coat of paint that was originally applied with all the characteristics of a new finish. Before applying a new starch coating, it is well to go over any spots in the walls, where it has been chipped or accidentally marred with some spare paint like that originally used. By the starch protective coat method, a well-applied, flat white factory paint can be made to give several years of good service as a light diffuser for daylight as well as artificial illumination, saving the cost of frequent repainting at a relatively small cost of water, laundry starch and labor.



SHOP LIGHTING maintenance truck equipped with lamp renewals and cleaning paraphernalia. With facilities of this type readily available there can be no excuse for empty sockets and wasted energy.

Maintenance

No plant engineer would allow a machine vital to his daily production stand idle because of a mechanical failure. Neither should he allow a reflector to hang idle because of a burnt out lamp or empty socket. Each reflector of a properly designed system has a particular area to illuminate and if it is not working, that particular area must be satisfied with a small amount of light that comes from the distant reflector units. Production in that area will be retarded because the operators' speed of working is largely governed by their speed of vision.

A maintenance schedule, preferably in conjunction with the cleaning periods should be drawn authorizing a responsible individual to make a note of the empty sockets and lamp failures and replace same immediately upon discovery with lamps of correct wattage and voltage. The voltage rating of a lamp renewal should be as near to the socket voltage as possible and not that voltage at the switchboard, because it has been found that a lamp burning 3 per cent below its normal voltage represents a loss of 10 per cent in its candlepower output; or in other words, a 115-volt rated lamp burning in a socket with 110 volts means a loss of 15 per cent in candle power.

In many of the large industrial plants where the lighting is of vital importance to production and a rigid cleaning and maintenance schedule is in practice, some special facility is used so that the equipment can be quickly and easily attended. Portable lamp carrying racks, similar to that shown in the accompanying illustration, containing spare renewal lamps, cleaning cloth and lamp renewal record cards, are used in some instances to save time and labor.

A good labor and time saving method for cleaning lamps and reflector equipment in large plant areas is the use of a maintenance truck equipped with a collapsible ladder, renewable lamp and reflector shelves, a metal wash tub, and cleaning paraphernalia. This truck may be provided with clamping brakes or folding legs to prevent rolling while in use. Another scheme, where an ordinary wooden, shop-material platform is surmounted by a collapsible ladder similar to the body of the maintenance truck, can be profitably employed. This ladder can be carried about the plant by means of an ordinary hand lift truck.

Industrial establishments that have adopted a systematic cleaning and maintenance schedule have obtained records such as were shown in Fig. 6, page 118, March issue of *Industrial Engineering,* which indicates that they are getting the most useful light out of the equipment for the power it consumes.

To Restore a Lighting System

The principal points to consider in the restoration of the lighting system may be outlined as follows:

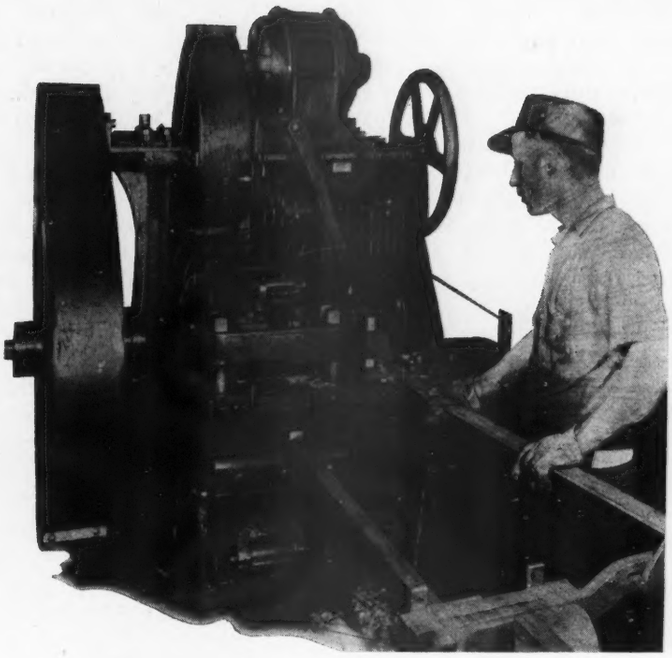
1. Wash reflectors and lamp thoroughly at least every third or fourth cleaning period.
2. Fill empty sockets and replace burnt and blackened lamps with new lamps of correct wattage and proper voltage rating. The voltage rating of the lamp should be at least no higher than the voltage at the socket when the system is in use. Avail yourself of the service of the lamp manufacturers in determining what the voltage rating should be.
3. Refinish ceiling and upper side walls in a flat white or a very light cream color.
4. Make some reliable employee responsible for the maintenance of the lighting system and give him sufficient authority to enable him to get the work properly done.

Correction Notice

In the article entitled "How to Connect Electrical Testing Instruments," by E. F. Lincoln, which appeared in the February issue, the designations of the instrument transformers shown on page 91, Fig. 20, should be reversed.

In both connections shown, the designations for current transformers should read "potential transformers" and the designations for potential transformers should read "current transformers."

ILLUSTRATING the use of a mechanical force-feed oiler on a spring eye forming machine in the automotive industry.



Automatic Lubrication

takes its place in

Services to Production

By ALLEN F. BREWER

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New York, N. Y.

AUTOMATIC lubrication by means of more or less self-functioning oiling or greasing devices, or systems involving centralized pressure, has indicated extensive possibilities in the promotion of industrial machine efficiency. For such equipment pressure lubrication, whether it may involve oil or grease, will, no doubt, be more positive and dependable than such other means of lubrication in which flow of lubricant may depend upon manual adjustment, temperature fluctuation or splashing.

These latter methods result in the development of but relatively low pressures, if any. As a result the lubricant in its course through a bearing clearance space will follow the path of least resistance. In other words, should oil grooves or other parts of the lubricating system be clogged with dirt or gummy deposits, these may not be dislodged by a virtually free flowing lubricant. The result will be impaired lubrication, with the subsequent development of solid friction and wear.

Where oil or grease is forced through under pressures ranging up to several thousand pounds, a lubricating system will be kept clean and flushed of non-lubricating deposits. The lubricant itself will be more nearly able to function as intended in the reduction of solid or metallic friction and the prevention of wear. The use of oil under pressure will also insure a certain amount of cooling, which may be decidedly advantageous should high operating temperatures be prevalent.

Temperature reduction can be most effectively brought about by flood lubrication, and the most familiar instance of this is the full force-feed system of lubrication as employed in many automotive engines today. On such equipment volume is a necessity to insure a material reduction in bearing temperatures. By forcing an excess of oil through such bearings, the very act of keeping temperatures down will enable that part of the oil which serves as the lubricating film, to more nearly function at its intended body or viscosity. The advantage of this will be that the possibility of metal-to-metal contact will be more effectively prevented, for the lubricating film will be more capable of withstanding the prevailing bearing pressures.

With the exception of but a few instances, industrial production machinery will not require the refinements of flood lubrication, because operating requirements will be such as to permit the use of either oil or grease, provided the proper means of application are employed.

Such means will involve the delivery of just about the right amount of lubricant at periodic intervals. Where oil is involved, the mechanical, force-feed lubricator is probably the most familiar device obtainable, although pressure oiling by use of a more or less built-in system of lubrication will be quite adaptable, provided the machine is so designed as to permit of its installation.

When dealing with centralized or other types of pressure oiling systems, it is important to remember that the cost of installation will vary in accordance with the number of parts to be served. Each will require more or less individual piping, with the accessory fittings, control valves and a sight feed indicator. There is also an element of complexity which must not be overlooked. This applies to any system of manifold grease lubrication which may involve application of the lubricant at a central point, with provision for subsequent distribution to the essential wearing elements of the machine.

It is difficult to draw a contrast between flood and intermittent systems of lubrication. Each, if properly installed should be economical in

operation. Where and when to install any particular system will depend upon operating conditions, temperatures involved, and the duty of the machine. Flood lubrication is ideal on a steam turbine. The bearings of a bread wrapping machine, or a textile loom, on the other hand, can be more effectively lubricated by a grease gun, a spring-pressure grease cup or the sight feed oiler.

The mechanical, force-feed oiler is probably the most extensively adopted device for the automatic lubrication of industrial machinery with fluid lubricants. It is capable of delivering oil in predetermined and accurately regulated quantities to frequently several dozen parts of a machine, according to the number of connections, and requirements of the wearing elements. But there is no provision for re-circulation of the oil. In operation, oil is taken from a central reservoir by one or more suitable pumps to be forced under the requisite pressure to the parts requiring lubrication.

Since it does not serve as an oil re-circulating device, the mechanical, force-feed lubricator will require more frequent replenishment of its oil reservoir, than will a force-feed circulating system. Oil in the former is used but once, unless provision is made for collecting it in suitable drip pans after it has passed through the bearings. Where such economy is practiced the used oil as accumulated can be readily purified or filtered and rendered suitable for re-usage. More frequently, it is customary to regulate the oil flow to the respective wearing elements so that just the right amount will be delivered with practically no waste.

Such a device is advantageous in that, as the operation of its pumps depends upon the operation of the machine to be lubricated, with direct connection through a lever or ratchet arm to some reciprocating element on the machine, flow of oil will automatically stop when the machine stops. Furthermore, the speed or rate of pumping is directly dependent upon the speed of the connected machine element. As a result, very accurate regulation of oil flow is readily attainable, according to the speed of each movable machine part requiring lubrication. All that is necessary after such regulation is to keep the lubricator reservoir properly filled with the right grade of oil. A suitable gage is usually installed to facilitate observation of the oil levels.

An offshoot of the mechanical force-feed lubricator is the so-called centralized pressure system of lubrication as applied to machine tools and chassis parts. Such systems are designed to function automatically, oil being delivered by way of suitable piping leading to the various parts requiring lubrication. All these pipes are brought together at a central tank or reservoir which is connected with a suitable pump capable of operation by either hand or foot power.

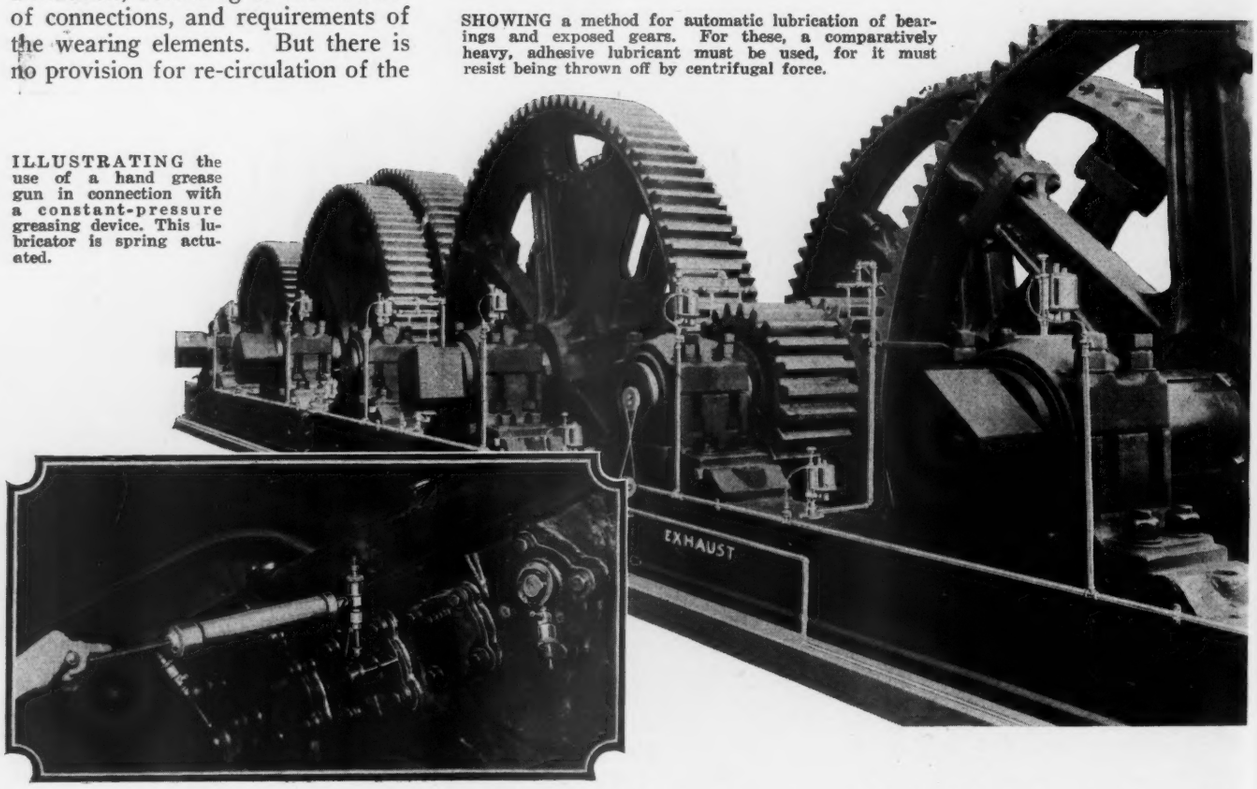
Another method of supplying oil automatically makes use of the principle of the wick feed, a suitable magazine or reservoir being located at each respective part, connected by piping to some adequate source of fresh oil supply. Periodically a charge of oil is delivered to each magazine. By syphonic action, the wick therein carries this oil in turn to the wearing elements, insuring a positive feed just as long as oil remains in the reservoir to saturate the wick.

Such means of lubrication are especially fool-proof and dust-proof in their design and operation. Unlike the mechanical, force-feed lubricator, however, they depend upon the human element for the operation of their pumping or recharging elements. Dependent upon the intelligence of the operator, this may at times be a certain disadvantage.

Pressure grease lubrication whereby the lubricant is supplied to bearings under more or less pressure is one of the most important developments in automatic lubrication and a decided advancement towards the attainment of more effective lubrication. Grease used to have to rely upon thermal conditions or more

SHOWING a method for automatic lubrication of bearings and exposed gears. For these, a comparatively heavy, adhesive lubricant must be used, for it must resist being thrown off by centrifugal force.

ILLUSTRATING the use of a hand grease gun in connection with a constant-pressure greasing device. This lubricator is spring actuated.



or less pumping action for its delivery to bearings. But this involved cessation of lubrication in event of any chance alteration of the conditions required within the lubricator. Therefore, while the individual grease cup may rightfully be classed as relatively automatic, it is not at all times positive in action, although it is decidedly economical. On the other hand, the use of pressure will in general result in the delivery of somewhat more grease to bearings over the long run, even though this may frequently be only supplied at periodic intervals.

Under certain conditions of operation and construction grease is without a doubt the only lubricant that should be used, just as, in contrast, there are others which will require oil. As a general rule the means of application of either is quite as important as the particular product which is to be used. In the case of grease lubrication of bearings, especially, pressure systems frequently give the most secure feeling, for in many cases the efflux of lubricant from exposed or visible bearing ends is taken as an indication that the parts are being properly lubricated.

Lubrication by means of pumping or temperature effects on a grease will in general not be as evident. To be true, such lubricators, as already stated, are more economical of grease, and if properly sealed against entry of foreign matter, should give equally as good lubrication as a pressure system. However, this may be false economy, unless bearings are periodically cleaned and flushed.

The average pressure grease lubricator is its own cleaner by virtue of the pressure it is capable of developing. Furthermore, while the grease cup is adaptable chiefly to plain bearings, the pressure gun can be also used to charge anti-friction bearing housings and gear cases.

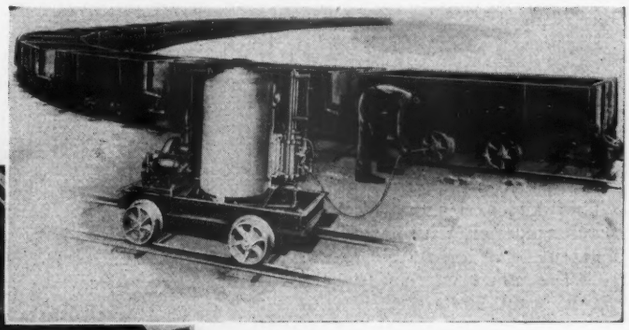
Pressure lubrication requires care. It cannot be done in a haphazard manner. Lack of time in the lubrication of certain industrial machinery will prevent the exercising of the care necessary. It is for this reason that the constant pressure grease reservoir used in connection with a grease gun for filling has been developed. Such a device is simply a spring actuated lubricator capable of being filled by means of a pressure gun through a standard form of check valve fitting. By careful adjustment of springs and regulation of the pressure exerted by the plunger on the charge of grease, the bearings will continue to be supplied with lubricant, yet there will be little or no chance of this latter being wasted through leakage.

Pressure grease lubrication is of decided advantage on industrial machinery where leakage of lubricants may be a detriment and a damaging element to the product manufactured.

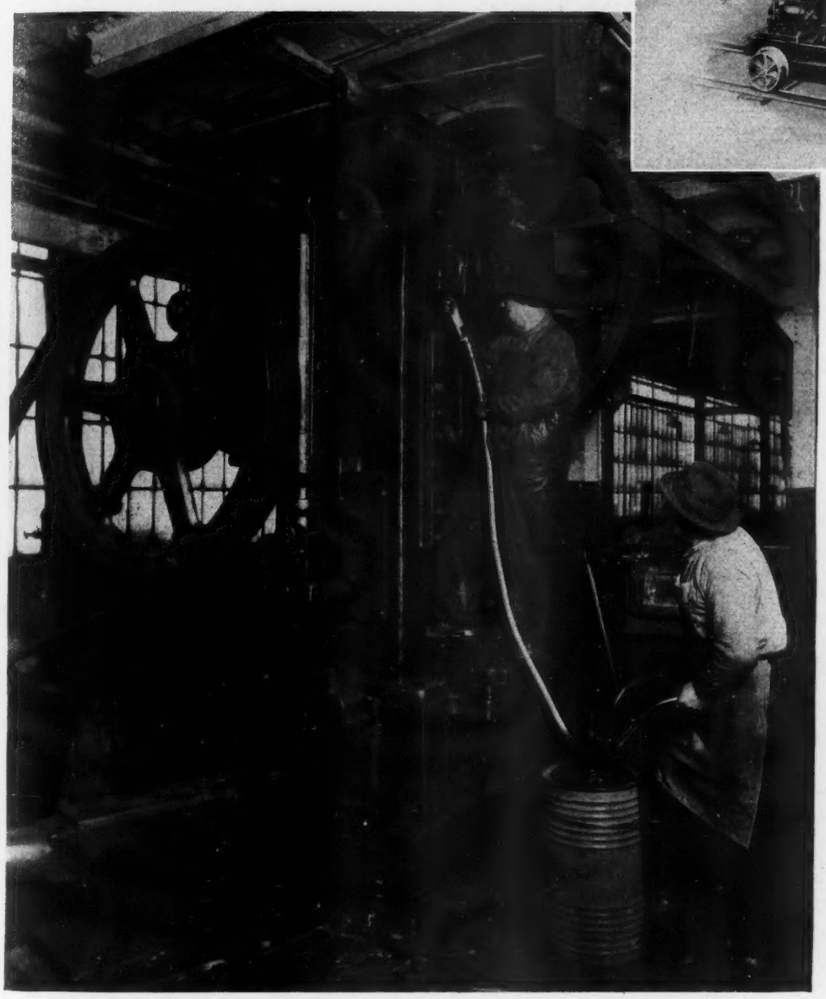
Take, for example, the baking, textile, leather or paper industries. At certain stages of production or manufacture the products or materials are in a more or less perishable state and can be readily damaged through contact with oil, and especially dirty oil. This holds true whether the oil gains entry from an imperfect oiling device, the use of the wrong grade of oil, or, as a result of grease separation or application of an excess of lubricant. Dripped, splashed or thrown lubricants become contaminated with dirt and are potential detriments to any perishable material which may come in contact with them.

Under such conditions the pressure grease gun of either the hand or power type is an adaptable piece of equipment.

THE POWER-DRIVEN grease compressor with suitable means of attachment for delivery of lubricant is especially adaptable for such where anti-friction bearings are involved.



LUBRICATING BEARINGS of a metal press by means of a drum-type grease compressor. Where high pressures are involved the application of lubricant under sufficient pressure to remove the old lubricant is decidedly essential.



NEW EQUIPMENT

For Plant Operation and Maintenance

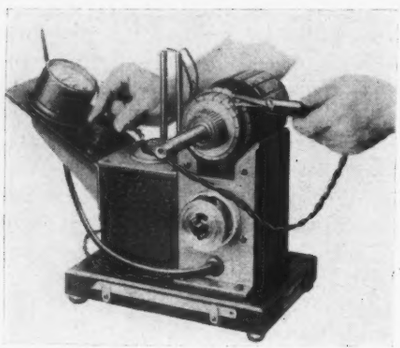
Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Allen Universal Growler

THE Allen Electric & Equipment Company, Kalamazoo, Mich., has developed a growler, known as Model A-32, for testing armatures up to 6 in. in diameter.

This device is provided with a 3-in. Jewell ammeter, with external zero adjustment. An adjustable rheostat controls the meter current to compensate for different kinds and sizes of armatures. The contact arms are adjustable to permit testing any armature. Current up to 8 amp. can be carried by the test points for blowing out, or detecting by smoke, any ordinary ground.

The growler is provided with a signal lamp which lights when the device



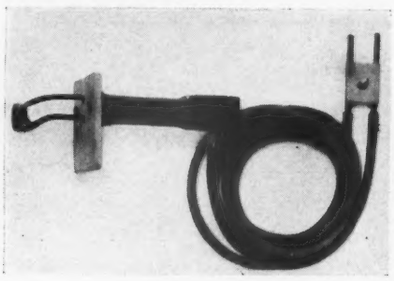
Allen Model A-32 Universal Growler

is in use, and thus prevents accidentally leaving current on after the completion of a test. A snap switch is employed to switch the growler on and off.

Lincoln Water-Cooled Carbon Electrode Holder

ANNOUNCEMENT has been made by The Lincoln Electric Company, Cleveland, Ohio, of the development of a water-cooled carbon electrode holder for heavy-duty, manual welding by the carbon arc process. Designed primarily to insure greater comfort and less fatigue for the operator, it has been found that the new holder effects a marked economy in the use of the carbon electrodes, as it is possible to use smaller-sized carbons at higher current density.

The holder consists of coiled copper tubing through which water constantly circulates, the carbon electrode being inserted through the coil. The holders



Lincoln Type W Water-Cooled Carbon Electrode Holder

are manufactured in sizes for use with ¼-in., 5/16-in., ⅜-in., and ½-in. carbons. A hand shield of compressed magnesium protects the operator's hand from the arc rays. The water cooling system also keeps the hand grip of the holder cool.

The hose which carries the water also carries the cable to the holder. Each of the two water tubes contains a light cable from the connector to the holder. The water flowing through the holder also acts as a cooling agent for the cables, so that the size of cable running to the holder is reduced to a fraction of the size otherwise necessary.

G. E. Strip Heater

AN electric strip heater announced by the General Electric Company, Schenectady, N. Y., may be applied either as an air heater or as a "clamp-on" device. It is designed for general purposes where electric heat is required, and is suggested for use in cabs, valve houses, pump houses, telephone switchboards, process machines, drying ovens, etc. The device is 24 inches long, 1½ inches wide and ⅜ inch thick. It is rated at 500 watts at 110 or 220 volts. Slots are provided in each end allowing the heater to be suspended in air or clamped to a metal surface.

Both terminals are at one end of the unit and project from the same side.

Front and back views of G.E. 500-Watt Strip Heater

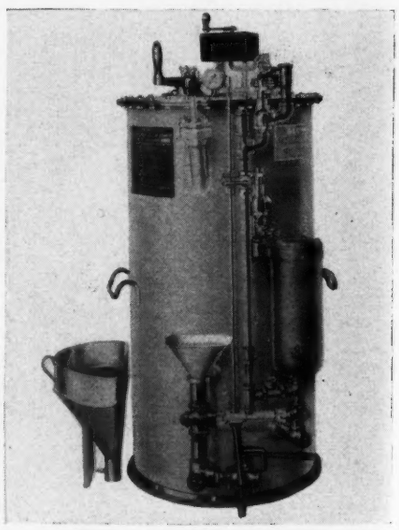
They are nickel-plated brass studs insulated from the sheath by mica washers and provided with screws and fittings for binding the connecting lead wires.

The current-carrying resistance wire inside the sheath is the usual nickle-chromium resistor wound in a helix in much the same manner as in standard G.E. sheath wire construction. The coil is supported at each end by a porcelain insulator and is stretched down the length of the unit four times.

Prest-O-Weld Medium-Pressure Acetylene Generator

THE Prest-O-Weld Type MP-101 medium pressure acetylene generator has been developed by the Oxweld Acetylene Company, 30 East 42nd St., New York City, to meet the demand for a stationary or portable acetylene generator that can be used in connection with either medium-pressure or low-pressure welding and cutting blowpipes. This generator is adequate for any type of welding or cutting operation and can easily be carried from place to place on a truck or wagon.

Heavy-gage material has been used in the construction of the generator,



Prest-O-Weld Medium-Pressure Acetylene Generator

and where strength is required for the fittings, steel castings have been used. Bronze welding has been used for joining the generator shell and fittings.

The carbide capacity of this generator is 30 lb., and the quarter size (¼x½-in.) carbide is used. A special funnel, which is held in place on top of the generator, is provided for filling the generator with carbide. The overall dimensions of the generator are, height, 60 in., and width, 34 in. The weight of the generator empty is 305 lb. With a full charge of carbide and water, the total weight of the generator is 623 lb. The generator can be inclined to an angle of 30 deg. from the perpendicular without tipping.

Allen Repair Shop Lathe

A SMALL lathe for turning commutators and handling a variety of the odd jobs, except screw cutting, that comes up in maintenance and repair work, has been placed on the market by the Allen Electric & Equipment Company, Kalamazoo, Michigan.

The driving motor can be mounted on an adjustable support behind the headstock, which it drives through a countershaft that is also mounted on the lathe bed. A three-cone pulley makes possible a considerable range of speed.

The headstock is bronze-bushed for a spindle that has a ½-in. hole through its entire length. Worm gears are used on the power feed. If desired, the

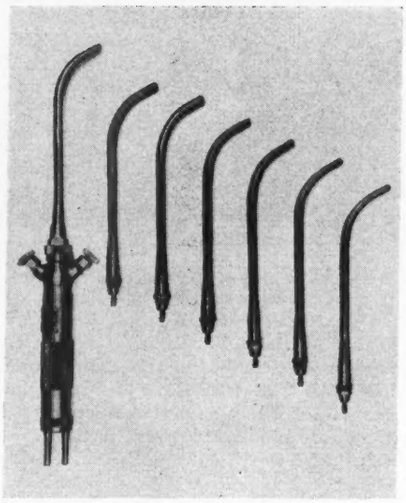
Allen Model A-67b Lathe

power feed can be disengaged and hand feed employed. The capacity of the lathe is 24 in. between centers. The swing is 10 in. over the bed and 6 in. over the carriage.

Oxweld Welding Blowpipe

THE Oxweld Type W-15 aircraft welding blowpipe has been placed on the market by the Oxweld Acetylene Company, 30 East 42nd Street, New York, N. Y. This device was designed especially for aircraft fuselage welding, but will undoubtedly find many applications in other fields. Like other Oxweld blowpipes it is of the injector type and can be used on low pressure acetylene supply.

Welding heads, seven in number, supplied with the blowpipe, are equipped with drawn copper tips to withstand high temperatures and are curved to reach hard-to-get-at places. Each welding head is detachable as a unit and each injector can also be detached from the welding head and replaced if necessary. The welding head is connected to the body of the blowpipe with a double conical seat and is held in place with a knurled-head nut. The handle is knurled to provide a good grip. The ⅛-in. oxygen and acetylene hose are connected directly to the blowpipe, the usual screwed hose connections being dispensed with.



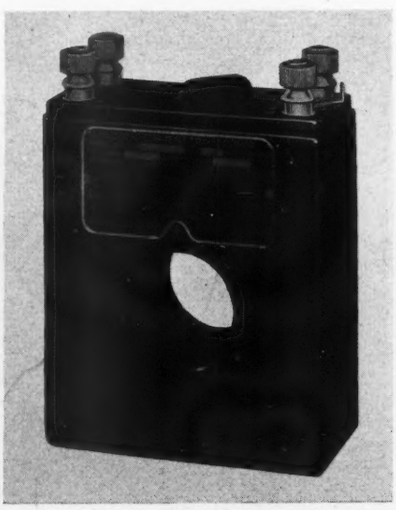
Oxweld Type W-15 Aircraft Welding Blowpipe

The various welding heads are all designed for a constant oxygen pressure of 20 lb. per sq. in., making it possible for the welder to change the heads without changing the adjustment of the oxygen regulator.

Weston Instrument Current Transformer

MODEL 539 current transformer is a small, light-weight unit recently introduced by the Weston Electrical Instrument Company, Newark, N. J. It has a 1-amp. secondary and when used with a proper instrument of that range, current measurements can be made from 0.2 to 200 amperes.

The advantage of this transformer over those with 5-amp. secondaries is that it permits the measurements of current below 1 amp. Model 539 has four self-contained primary ranges of 2, 5, 10 and 20 amp. which are changed by means of a range-changing switch on the top of the transformer. Ranges



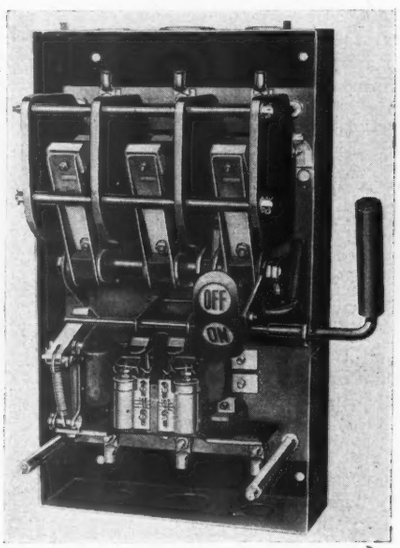
Weston Model 539 Current Transformer

of 200, 100 and 50 amp. are also available by passing the conductor, one, two, or four times through the hole provided for that purpose in the transformer. This is known as an inserted primary.

This model is designed as a companion instrument to Model 528 and is completely inclosed in a mottled red and black Bakelite case to match. It has a guaranteed accuracy of 1 per cent from 25 to 150 cycles. It can be used, however, with equal accuracy with Weston portable models 155, 433 or Weston panel Models 517, 476, 429 and 156 having ranges of 1 ampere.

Roller-Smith Type EAF Circuit Breaker

THE Roller-Smith Company, New York, N. Y., announces a line of small, enclosed, air-break, circuit breakers designated as Type EAF. These



Roller-Smith Type EAF Circuit Breaker

breakers are offered for the protection of motors and feeder circuits against overload and voltage failure.

Among the features that characterize these circuit breakers are: All breakers of this type are free handle (nonclosable on overload). Simplicity of operation: to close the breaker the handle is pulled down; to open it, pull the handle up. There are barriers between the poles and arc chutes in all breakers of this type. The overload coils can easily be replaced with new coils of the same capacity or of any listed capacity. The direct-acting time limit resets itself immediately after the breaker opens.

All parts of the mechanism are in plain sight and easy to get at, and ample wiring space has been provided at the top and bottom.

The Type EAF circuit breakers are made in capacities of from ½ to 80 amp., 250 volts d.c. and 550 volts a.c., in two- and three-pole designs.

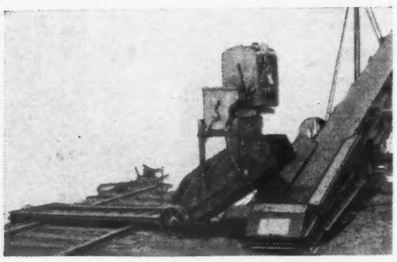
G. E. Relay

A RELAY for use on various types of alarm circuits, and bearing the designation CR-2810-1245 has been announced by the General Electric Company, Schenectady, N. Y. This device is of the normally closed type and functions to actuate a warning signal on the failure of power.

Applications of the relay are expected to be many and various, ranging from simple failure of power where no more serious consequences result, to more involved circumstances where power failure would result in serious losses such as the failure of heat in an incubator. The warning signal controlled by the relay may be a bell, a horn, a whistle, a light or any other common device, and probably would be energized by batteries.

Barber-Greene Car Unloader

A LIGHT car unloader for unloading hopper bottomed cars of coal and coke has been announced by the Barber-Greene Company, Aurora, Ill. This unit was originally designed as a feeder attachment and constructed to



Barber-Greene Light Car Unloader

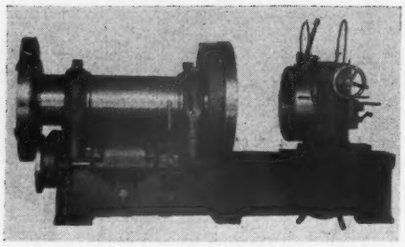
take its power from a B-G flight conveyor.

The addition of a power unit, which may be either gas or electricity, and which has been done very simply, has converted this unit into a self-contained unloader. This model has a capacity of 1 ton a minute. It is only 3⅝ in. high over the rails and allows ample clearance for the largest hopper doors. The bottom plates over which the coal and drag flights travel are of high carbon steel and are renewable. The complete machine weighs 1,700 pounds.

Bignall & Keeler Duplex Machine

ANNOUNCEMENT has been made by the Bignall & Keeler Machine Works of the N. O. Nelson Manufacturing Company, Edwardsville, Ill., of the development of a duplex pipe threading and cutting machine, designated as No. 12, having a capacity ranging from 4-in. pipe to 13⅜-in. A.P.I. casing. This machine was especially designed for oil field work.

Eight speed changes are provided through broad-face steel cut gears running in oil in a compact gear box with one set of gears outside the gear



Bignall & Keeler No. 12 Duplex Pipe Threading and Cutting Machine

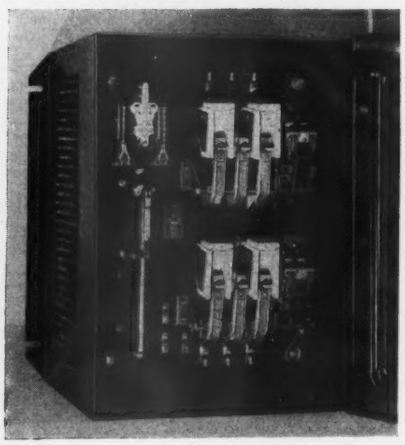
box. A two-way positive clutch is mounted on the bed shaft. This clutch has both fast and slow positions and provides a quick stop and start for the machine, and enables the operator to shift quickly to the higher speed for cutting off operation on large pipe sizes.

A three-jaw independent chuck is mounted at each end of the arbor. Either or both of them may be used for gripping the pipe for the threading and cutting operations. The rear chuck is equipped with flanged grippers for making and breaking up flanged fittings.

The arbor has a 15¼-in. bore. The Peerless sliding die-head can be arranged for dies of any desired width. The carriage has a 33-in. travel, giving ample room for cutting and threading operations. Surplus power for all requirements is furnished by a wide-face double belt or a 7½ hp. motor.

Monitor A.C. Automatic Starter

A STARTER for squirrel-cage motors employing a timing relay which gives unusual results has been developed by Monitor engineers. The time period of this relay is adjustable over a wide range, and once set, it remains constant independent of the surrounding temperature. This unit is being manufactured by the Monitor Controller Company, Baltimore, Md. Except for the thermal timing device which controls the operation of the accelerating contactors, the starter is a normal Monitor resistance type starter provided with overload inverse time-element relay and low-voltage protection. In this starter the resistance employed in acceleration is cut out at a definite adjustable period after the starting switch is closed, the period being determined by the compensated thermal timing device.

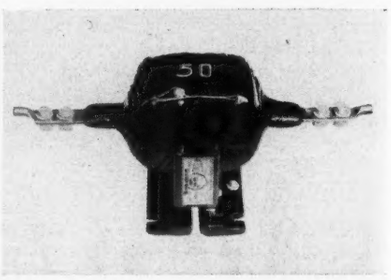


Monitor A.C. Automatic Starter

The principle of the relay is as follows: A pivoted walking beam equipped with an arm extending at right angles and which carries a contact that opens and closes as the beam tips one way or the other, is kept in position by two equal and identical wires held taut by a spring. The exact position of the beam is determined by the relative lengths of the wires. Changes in room temperature affect both alike, and therefore do not move the walking beam. One of the wires, is included in an electric circuit and current heats it causing it to expand. As it expands the beam tips, moving the arms to the left and closing the contact. The exact time required to close the contacts is adjusted by means of varying the air gap with a screw.

Westinghouse Current Transformers

A CURRENT transformer that is suitable for all applications with secondary burdens up to 50 volt-amp. at any power factor and for frequencies between 25 and 133 cycles, and on lines up to and including 6,900 volts, has been announced by the Westinghouse Electric and Manufacturing company, East Pittsburgh, Pa. According to the



Westinghouse Current Transformer with Hipernik Cores

announcement extreme accuracy is obtained in this Type NA transformer by using Hipernik instead of silicon steel for the core. Hipernik, which is an alloy made of pure nickel and electrolytic iron, specially treated, is non-aging and has three times the permeability of regular silicon steel and but one-half the losses.

The primary coil is almost circular, thus assuring strong mechanical construction. The coils of low-current rating are made of light copper strap.

The secondary coil is also circular. All leads are brought out to a terminal block. The end frames of sheet steel are used to hold the laminations tightly together. They are provided with feet suitable for rigid mounting on a flat surface, and on transverse or parallel pipe frame work by means of standard sized U bolts.

G. E. Incandescent Lamp Deposit Remover Method

THE development of a practical method for removing the black deposit which gradually collects on the inner surface of high-powered incandescent lamps has been announced by the Lamp Department Laboratory, Incandescent Lamp Department, General Electric Company, Cleveland, Ohio.

The deposit-remover is a tablespoonful of coarse tungsten powder placed inside the lamp before it is sealed. After the lamp has become blackened from use, the operator needs but to remove the lamp from its socket, invert it, and "sweep" the filament deposit off the inner glass surface. The lamp is thereby restored to its former efficiency as good as new. With the bulb-blackening difficulty practically removed, the lamp filament may be heated much nearer to its melting point, without endangering the bulb and without shortening the customary 100-hour life for which the lamps are designed.

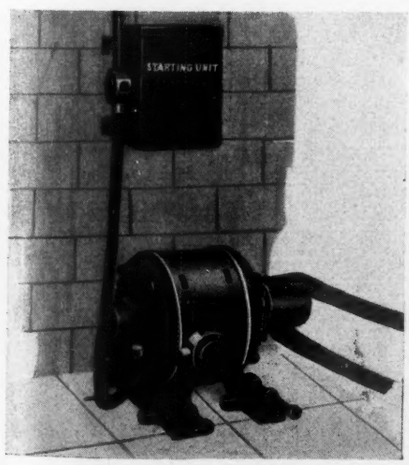
This method for cleaning the inside of the bulb has been applied to high-intensity lamps.

Howell "Brush-Less" Single-Phase Motor

THE Howell Electric Motors Company, Howell, Mich., announces the development of a Red Band "Brush-Less" Type CI (condenser start induction run) single-phase motor with characteristics resembling those of a polyphase motor, and suitable for use for single phase operation of elevators, hoists, automatic doors and windows, woodworking machines, and so on.

Although it has no brushes, commutator, wire-wound rotor, internal switching device, or soldered rotor contacts, it has, it is claimed, starting and pullout torques conforming to corresponding polyphase ratings as well as conforming power factors and efficiencies.

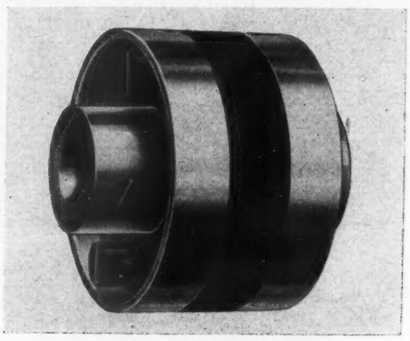
It can be plugged and reversed at full speed. The stator windings are similar to an ordinary two-phase motor, with a starting condenser (patents pending) connected across one phase. The starting torque is supplied by an external starting unit containing the starting condenser and a simple contactor which automatically disconnects it from the circuit when the motor comes up to full speed. The motor then operates as an ordinary single-phase induction motor.



Howell Type CI Brush-Less Single Phase Motor

Ajax Type C Flexible Coupling

THE Ajax Flexible Coupling Company, Westfield, New York, has recently designed a light-duty, flexible coupling, which is primarily intended for manufacturers of machinery who use a great number of fractional and small horsepower couplings and whose equipment requires a connecting unit of positive stability, capable of protecting the motor and driven machinery for the life of the equipment.



Ajax Type C Flexible Coupling

This Type "C" coupling is made of two die-cast flanges of identical diameter with wide faces and with the surfaces made true to the bore. The two flanges are connected by means of four set screws, two in each flange, screwed through the flanges and into four nuts which are permanently molded into a rubber center piece. This rubber disk acts, of course, as the shock absorbing medium.

It is made in bores of from ½ to 1¼ in., and it is so designed as to correct slight misalignment and absorb the shocks of starting and stopping.

Ideal Fuse Pullers

A LINE of fuse pullers with a tested capacity of 35,000 volts has been introduced by the Ideal Commutator Dresser Company, Sycamore, Ill. These tools are made in four sizes; the Midget, with three laminations, 5 in. long, and with gripping jaws at one end only. This model is for use on small fuses, grid leaks, etc., of from ¼ to ½ in. in diameter.

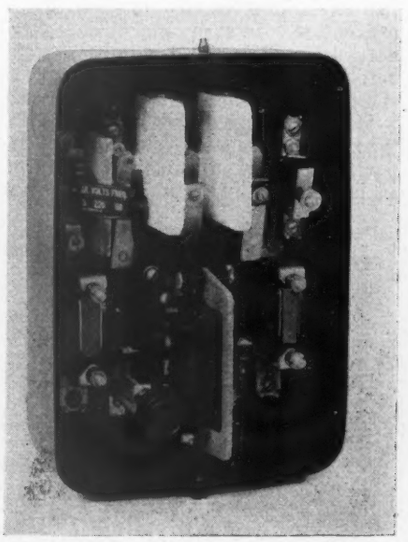
The next size, known as the Pocket size, and made with five laminations, is 7½ in. long and can be used for handling fuses of from 0 to 200 amp., 250 volts and from 0 to 100 amp., 600 volts. The Giant size, 12 in. long, and with seven laminations, is for handling fuses of from 100 to 600 amp., 250 volts and from 60 to 400 amp., 600 volts. The largest size, known as the Jumbo, is 20 in. long. It has nine laminations and can handle fuses of from 200 to 800 amp., 250 volts and from 200 to 600 amp., 600 volts.

G. E. Magnetic Switches

THE addition of two switches to its line of general-purpose starters for small alternating-current motors has been announced by the General Electric Company, Schenectady, New York. The CR-7006-D-26-A is a three- and four-pole magnetic switch with self-contained "Start" and "Stop" stations, and the CR-7006-D-26-D is a switch for similar service but designed with additional wiring space.

The CR-7006-D-26-A is of standard design incorporating features for overload protection and undervoltage protection or release. It is used for starting and protecting small alternating-current motors that can be thrown directly on the line. It consists of a triple-pole, barrier-type contactor and a double-coil, temperature-overload relay, all mounted on a molded base in a drawn-shell inclosing case. Added to these are starting and stopping contacts ordinarily provided by a remote-control, push-button station. It is expected to be of particular value when used in installations where it is desired to locate magnetic switches at the driven machines.

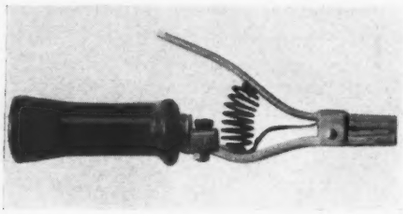
The CR-7006-D-26-A, although for the same general class of application, is designed for use with remote push-button stations. Its principal advantage is the especially large amount of wiring space provided. Mechanically, the switch mechanism is located below the center of the box to prevent interference with the mounting holes.



G. E. CR-7006-D-26-A Magnetic Switch

Lincoln Improved Type T Electrode Holder

THE Lincoln Electric Company Cleveland, Ohio, announces the development of an improved type of electrode holder for metallic arc welding, designated as the Type T, which was



Lincoln Improved Type T Electrode Holder

designed for greater operator convenience.

The holder consists of a clamp to hold the electrode while welding. An easy release feature permits changing electrodes quickly. It is claimed that the holder operates exceptionally cool, because the welding current is carried from the point of cable entry to the copper jaws by copper strips of low resistance. The copper tips on the jaws reduce the sticking of the electrode to the jaws resulting in faster and easier change of electrodes and longer life for the holder.

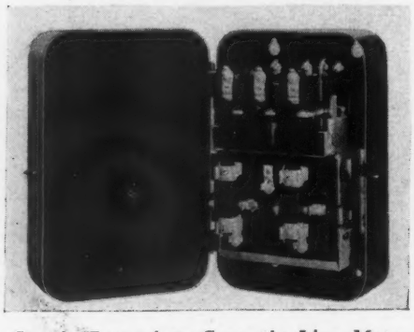
All metallic parts of this holder are coated with non-tarnishing cadmium plating.

Condit Type A-30 "Cross-the-line" Motor Starter

THE Condit Electric Manufacturing Corporation announces the development of a "cross-the-line" motor starter, known as the Type A-30, for use with squirrel-cage induction motors up to 20 hp. at 550 and 440 volts; 15 hp., at 220 volts; and 7½ hp., at 110 volts.

This starter is of particular interest in that it involves the function of arc prevention. Interrupting devices have been directed in the design of the circuit in order to extinguish the arc as speedily as possible after it has formed.

Having no barriers or arc chutes, the type A-30 is unusually simple and compact, according to the manufacturer. It is inclosed in a pressed-steel case



Condit Type A-30 Cross-the-Line Motor Starter

arranged for conduit knockouts, and is furnished with thermal relays for time-lag overload protection, as well as for undervoltage protection.

Industrial Controller Now a Division of Square D Company

ANNOUNCEMENT has been made of the consolidation of the Square D Company, Detroit, Mich., and the Industrial Controller Company, Milwaukee, Wis., two major units engaged in the manufacture of safety devices, panel boards and automatic motor control. The former Industrial Controller Company will now be known as the Industrial Controller Division of the Square D Company.

Sterling Grinders

A LINE of inclosed, ball-bearing, air-cooled buffers, grinders and polishers has been introduced by Sterling Electric Motors, Inc., Telegraph Rd. at Atlantic Blvd., Los Angeles, California.

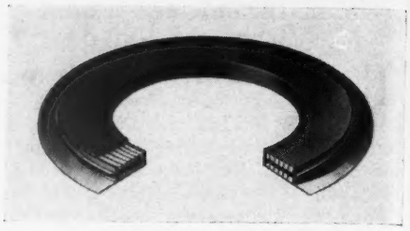
Sterling Floor Pedestal Combined Grinder and Buffer

These units are made in floor-pedestal and bench types with motor capacities ranging from ½ to 5 hp. Motors can be obtained in the single-phase type for 110 or 220 volts and in the two- and three-phase types for use on 220 or 440 volts.

"Flexitallic" Armor-Clad Gasket

ANNOUNCEMENT has been made by the Flexitallic Gasket Company, Camden, N. J., of the development of a gasket, designated as the armor-clad "Flexitallic" that will take care of the most severe, modern service conditions, such as high pressure, high temperature and even acid conditions.

One of the advantages claimed by the manufacturer is the web which extends out to any width desired de-



"Flexitallic" Armor-Clad Gasket

pending upon the inside diameter of the bolt circle. For example, if the inside diameter of the bolt circle is 10 in. and the inside diameter of the pipe is 6 in., the armor-clad "Flexitallic" is made in such a way that the gasket proper fits almost flush and concentric with the opening of the pipe, being held in place by the web which in turn is supported by the bolts. The armor is made of thin sheet aluminum. The accompanying illustration shows the details of construction.

G. E. Textotile Weatherproof Sockets

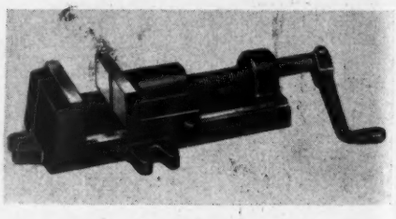
SOCKETS, composed of molded textolite bodies to which are assembled a screw shell and center contact with leads attached, and made weatherproof by means of a special bushing, have been developed by the Merchandise Department of the General Electric Company, Bridgeport, Conn. These sockets are designed particularly for use in outdoor string lighting, signs, damp cellars, or any place subjected to dampness, weather, steam vapor or acid fumes.

They are rated 660 watts, 600 volts, and are listed as GE-2750 and GE-2751.

Ammco Drill Press Vise

A TOOL, known as the Ammco Drill Press Vise, and said to provide a quick and easy means of setting up all kinds of drilling operations, has been introduced by the Automotive Maintenance Machinery Company, 816 West Washington St., Chicago, Illinois.

The jaws of this tool are machined to provide a positive grip on the material being drilled. A V-shaped slot in the movable jaw furnishes a rigid support for all vertical work. The handle is swiveled, which permits the use of the vise in positions which would otherwise be extremely awkward or impossible. The jaws are 3½ in. wide and 1½ in. deep and open to admit work 4½ in. wide.



Ammco Drill Press Vise

Krupp "Nirosta"

AN alloy steel, designated as "Nirosta," which was perfected by the Krupps, Essen, Germany, from heat-treatment experiments on chrome nickel steel of certain analysis, has been placed on the market.

Norosta is an alloy that is corrosive- and heat-resistant and which can be machined, welded, spun, formed, polished and drawn in the form of wire to a diameter of 0.001 in. Utensils made from Nirosta resist mars and scratching; heat does not warp them, neither do they dent. Containers, drums, and tanks made of Nirosta protect without self-deterioration, the various liquids of the food industry and equipment in chemical, paper, oil refineries and other plants.

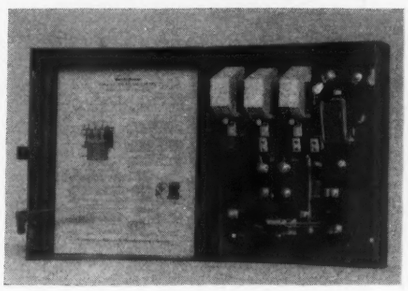
The Krupp Nirosta Company, Inc., of Delaware, has been formed for the purpose of extending the practical application of this alloy and controlling its manufacture and use. Licensed to manufacture Nirosta under the Krupp Nirosta Company patents, are Ludlum Steel Company, Watervliet and Dunkirk, N. Y., Central Alloy Steel Corportation, Massillon, Ohio, and Firth-Sterling Steel Company, McKeesport, Pa. Sub-licenses have been granted to Lukens Steel Company, which will obtain the material in the form of slabs and roll it into plates; the Babcock and Wilcox Company, which will manufacture tubes; and Spang, Chalfont and Company, which will manufacture pipes.

Westinghouse "Deion" Contactor for Linestarters

ANNOUNCEMENT has been made by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., of the development of the application of "Deion" contactors on Class 11-200 linestarters.

This "Deion" contactor, it is claimed, confines, divides and smothers the arc quickly without the usual flash and attendant scattering of flame. Not only does it provide for a greater degree of safety to the operator, but it also permits a smaller enclosure and consequent decrease in the overall size of the starter. The contacts are guaranteed to rupture from twelve to sixteen times their normal current carrying capacity at rated voltage under the most severe operating conditions of low power factor and sustained voltage.

During operation the following sequence takes place: the arc resulting from opening the circuit is drawn in air; it is blown into the deionizing chamber by a magnetic field; the original arc is broken up into many short arcs; each short arc is magnetically rotated to extinction; complete deionization occurs, as the line current passes through zero, and the circuit is broken.



Westinghouse Linestarter, "Deion" Equipped

United Tractor

ANNOUNCEMENT has been made by the United Tractor and Equipment Corporation, 612 N. Michigan Ave., Chicago, Ill., of the development of a medium-capacity tractor for industrial power needs. This tractor is being built by the Allis-Chalmers Manufacturing Company under contract for the United Tractor and Equipment Corporation.

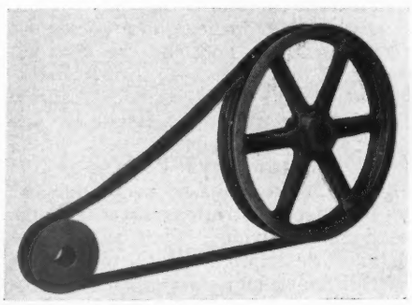
Among the features claimed for the tractor are great power in proportion to weight, a high degree of flexibility and modern automotive design. An unusual feature is an automotive-type transmission which provides four speeds forward and one reverse.

It is powered by a four-cylinder 40 hp. engine of special Continental design. The engine is equipped with an air cleaner of the centrifugal and oil-cleaner type, an oil purolator, gasoline filter, oil pump and full-pressure lubricating systems, in-built variable speed governor and water pump. Anti-friction bearings of either roller or ball type are used for all bearings in the transmission. The net weight of the unit is 3,900 lb. without water, fuel or special equipment. The overall length is 118½ in., overall width, 63 in., height 53¼ in. Although the tractor is low hung, its construction provides standard clearance.

United Tractor and Equipment Company Tractor

Fairbanks, Morse "Flex-Mor" Drive

ONE of the recent developments in V-belt drives is known as the "Flex-Mor" Drive which is a product of Fairbanks, Morse & Company, Chicago, Ill. The belts which are used with this drive are built up of an outer belt jacket of duck which has been treated with rubber to improve its wearing qualities. The various elements of the belt are assembled in a mold and vulcanized together into a unified structure. This drive is the result of numerous field and dynamometer tests to determine the factors of belt angles, slippage, the life of belts of various constructions, and power capacity.



Fairbanks, Morse "Flex-Mor" Drive

The sheaves are made of semi-steel and have been designed with particular reference to the angle and depth of the grooves so that the belt slippage is a minimum. At the same time, the relation between the angles of the belt sides and the grooves are such that the belt makes a gradual contact with the grooves as it bends around the sheaves. Due to the wedging action of the belts in the grooves and to their inherent elastic qualities there is no sudden grabbing of the load and sudden shocks to the driving and driven machine.

TRADE LITERATURE
You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

(74) BALL BEARINGS—"The story of Ahlberg Ground Bearings," covers in detail the development of the production processes which have made it possible to reclaim worn ball bearings to a point of serviceability "as good as new." It tells of the system of exchange which the Ahlberg ground bearing service has built up and includes many interesting reports from men, who have made actual comparative service tests of these replacement bearings, together with new bearings of the same type and in the same service. —Ahlberg Bearing Company, Chicago, Ill.

(75) TRANSFORMERS—There has been issued a new bulletin No. 161, containing instructions for the installation and operation of power and distribution transformers. The bulletin consists of 20 pages, and goes into detail regarding not only the installation and operation of transformers, but also their construction.—Wagner Electric Corporation, St. Louis, Mo.

(76) LUBRICATING DEVICES—Catalog No. 23, contains 68 pages devoted to full size illustrations together with sectional drawings, dimensions, and detailed descriptions of the 372 styles of oil cups and lubricating devices manufactured by this company.—Gits Bros. Manufacturing Company, 1940 South Kilbourn Ave., Chicago, Ill.

(77) MAXIMUM DEMAND METER—A new bulletin on the Lincoln Maximum Demand Meter is divided into two parts. Part 1 contains a brief non-technical description of the Lincoln principle of operation, and an illustrated description of the various Lincoln models now available. Part 2 contains a technical discussion of the Lincoln principle of operation.—Lincoln Meter Company, Incorporated, Springfield, Ill.

(78) ELECTRIC FURNACES—A film is now being prepared showing the operation of high frequency induction furnaces. It will be available to engineer's clubs and educational institutions within the next few weeks.—The Ajax Electrothermic Corporation, Trenton, N. J.

(79) TRAMRAIL SYSTEMS—A recently issued leaflet contains a picture index of some of the types of materials handling equipment listed in Tramrail Catalog No. 4.—Cleveland Electric Tramrail Division of The Cleveland Crane and Engineering Company, Wickliffe, Ohio.

(80) SAND HANDLING SYSTEM—A new booklet describing the Rex Foundry Sand Handling System covers in detail the uses of material handling equipment in foundries, and describes in particular the application of Rex equipment.—Chain Belt Company, Milwaukee, Wis.

Coming Events

National Fire Protection Association—Annual meeting, Memphis, Tenn., May 13-16, inc. Franklin H. Wentworth, managing director, 60 Batterymarch St., Boston, Mass.

American Gear Manufacturers Association—13th annual meeting, May 16 to 18 incl., Hotel Statler, Cleveland, Ohio. T. W. Owen, secy., 3608 Euclid Ave., Cleveland, Ohio.

National Association of Purchasing Agents—Annual Convention, June 3 to 6 incl., Hotel Statler Buffalo, N. Y. B. W. Hall. assistant secretary, 11 Park Place, New York City.

Association of Iron and Steel Electrical Engineers—Iron and Steel Exposition. (The Power Show of the Iron and Steel Industry) Wm. Penn Hotel, Pittsburgh, Pa., June 17-21, inclusive. Inquiries for booth reservations address J. F. Kelly, Managing Director, Empire Bldg., Pittsburgh, Pa.

National Association of Power Engineers—47th Annual Convention, Chattanooga, Tenn., Sept. 9 to 13, inc. The Power and Mechanical Exhibition will be conducted in conjunction with the convention. Ivon F. Pieters, president, Plibrico Jointless Firebrick Company, 1800 Kingsbury St., Chicago, Ill. S. M. Chapman, secretary, 5909 Kennerly Ave., St. Louis, Mo.

(81) FIRE PUMPS—Bulletin No. 104 describes Chicago electric centrifugal fire pumps in both the single stage and multistage types. It also contains several blueprints of typical layouts showing all parts and connections.—Chicago Pump Company, 2300 Wolfram Street, Chicago, Ill.

(82) SCRULIX ANCHORS—A recently issued folder describes the new style Matthews Scrulix Anchors.—W. N. Matthews Corporation, 3720 Forrest Park Boulevard, St. Louis, Mo.

(83) BELT CONTACTOR—Bulletin No. 270 contains a brief description and illustrations of the U. G. automatic belt contactor.—T. B. Wood's Sons Company, Chambersburg, Pa.

(84) HEATING—The fields covered by the information in the recent Westinghouse Electric Industrial Heating Catalog are those wherein electric heat has shown the most promise, such as heat treating and enameling; melting of alloys and metals; and electric heating elements. The general data section preceding the specific information will be of great assistance in applying electric heating apparatus to a job. It includes concise definitions of heating terms and practices, together with methods of determining size and capacity of equipment, cost of operation and rate and quantity of production.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(85) TWISTED SERVICE CABLE — A new booklet on twisted service cable has just been issued containing complete descriptions of house service and street lamp connections, and a special section on specifications with a detailed table of weights and sizes.—Okonite Company, Passaic, N. J.

(86) SWITCHES—A line of instrument, control and auxiliary switches, suitable for use with all types of circuit breakers and known as Type W is fully described and illustrated in circular 1821.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(87) FANS—9-in. stationery fans for use on alternating current are the subject of a new leaflet bearing the designation 17-2.—Century Electric Company, St. Louis, Mo.

(88) PUMP CONTROL APPARATUS—Bulletin 140 contains a complete illustrated description of control apparatus for electric centrifugal pumps including control panels, control boards, float switches and automatic alternator.—Chicago Pump Company, 2300-2336 Wolfram St., Chicago, Ill.

(89) UNILETS—There has just been issued a 36 page bulletin, 9-A, on Appleton Malleable No-thread Unilets. A copy of this bulletin will be sent upon request.—Appleton Electric Company, 1701-1729 Wellington Ave. at Paulina, Chicago, Ill.

(90) PULLEYS—A new 116 page catalog of pressed steel products has just been issued. The list of equipment described includes steel split belt pulleys, pressed steel shaft hangers, pressed steel hand trucks and pressed steel reels, spools and beams.—The American Pulley Company, 4200 Wissahickon Ave., Philadelphia, Pa.

(91) PRESSURE REGULATOR—Bulletin 1100 describes E C & M automatic altitude and pressure regulators and cushion tanks for use on both alternating and direct current.—The Electric Controller and Manufacturing Company, Cleveland, Ohio.

(92) LIGHTING—Bulletin No. 500 entitled "The Lighting of Modern Office Buildings" has just been issued.—Holophane Company, Incorporated, 342 Madison Ave., New York, N. Y.